

"THEORY INTO PRACTICE

ADVANCE ORGANIZER MODEL AND CONCEPT ATTAINMENT MODEL IN TEACHING OF CHEMISTRY

Orientation Programme cum Workshop (First Phase) 16-21 August, 1988

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Programme Team :	Dr. I. P. Aggarwal Dr. P. N. Pathak Dr. S. P. Saxena
Editors :	Dr. I. P. Aggarwal Dr. P. N. Pathak
Consultancy :	Prof. S. N. Tripathi
Coordinator :	Dr. S. N. L. Bhargava.

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FOREWORD

Education is the process of acquiring knowledge. Simple meaning of education is to provide such profitable experiences to the individual which will help him grow physically, mentally, morally and spiritually. During the last decade or so, a global rethinking has taken place to make education and science education in particular more meaningful. The focus on acquisition of knowledge has shifted from teaching to learning. The teaching today is mainly being visualized as an interactive process in which teacher and students both have their active role in the process of learning. The democratization of teaching thus thrusts a vital responsibility on the shoulders of teacher training institutions which are engaged in preparing competent science teachers, who can act as facilitator rather than mere dispenser of knowledge.

A model of teaching is a plan or pattern that can be used to shape curriculum towards guiding instruction in the classroom. Models of teaching have resulted from the experiences of psychologists regarding the behaviour of teacher in a classroom. The principal idea underlying various models of teaching is that a single best way to teach does not exist and as such, different teaching strategies may be suitably used by a teacher to realize different instructional goals. Models of teaching provide a real opportunity of integrating "Content and process of education", as content is the focal point here. For an ordinary classroom teacher it is not possible to appreciate this new approach of instruction unless it is presented to him in a simple, easy and practical way.

I am happy to record that my colleagues of Chemistry Section of the College, have conducted two inservice programmes of higher secondary teachers in their area of discipline and equipped teachers with appropriate training to use Advance Organizer Model and Concept Attainment Model in teaching of Chemistry. My colleagues went a step further and developed few model lessons through deliberations in these programmes. I am sure teachers practicing chemistry at the higher secondary stage would find this material useful and interesting. Since this type of work is a maiden attempt in our country, suggestions and views for improvement of the material would be highly appreciated.

Bhopal

April 28, 1990

Prof. P. K. Khanna
Principal
Regional College of Education
BHOPAL

P R E F A C E

The content of Chemistry and the method used in teaching subject this have been subjected to critical appraisal and as a consequence radical changes are appearing. The reason being that education never remains static and it is always better to look for new trends.

The National Policy of Education (NPE) 1986, stresses the importance of Science education in these words, Science education will be strengthened, so as to develop in the child well defined abilities and values such as spirit of enquiry, creativity, objectivity the courage to ask questions and an aesthetic sensitivity.

With the introduction of 10+2 pattern of curriculum in almost all states many old units of syllabus have been replaced, modified and redesigned by new and upgraded content units. The new syllabus has made it possible to go much further in systematizing and explaining the facts of Chemistry.

How then to teach chemistry at this stage for effective learning? One way of effectively transacting the content at the +2 stage could be the use of models of teaching, namely advance organizer (A.O.) model, concept attainment model and Inquiry training model, which are few amongst the many models of teaching. A beginning to use Advance organizer model and concept attainment model was made by the Chemistry section of the Regional College of Education, Bhopal through two programmes conducted from 16-8-68 upto 21-8-68 and 29-1-90 upto 3-2-90.

According to weil and Joyce, an advance organiser can be expressed as follows :

1. It should be at a higher level of abstraction, generality and inclusiveness of the learning material.
2. It should explore the essential features of the concept.
3. It should overview all major similarities and differences between issues and new ideas before they are encountered.
4. It should link the previous background or experience to the organiser. Here it will be appropriate to consider David Ausubels, goal of learning subject matter, with consideration for the improvement of presentation of method of teaching, in order to acquire mastery of academic material. His theory of meaningful verbal learning deals with three aspects.

1. How knowledge is organised ?
2. How mind works to process new information ?
3. How teachers apply this idea during class room instruction ?

Thus the theory of advance organiser model of teaching provides information to teachers for selecting, organising and presenting new information. We are aware that during inductive approach of teaching, the students discover or rediscover concepts, but the advance organiser model provides concepts and principles to the students. This helps to strengthen students cognitive structures directly.

Can we teach Chemistry with the use of A.O. to students, that will be meaningful?

The answer is that it depends upon the learner the material and the method of presentation. If the learner begins with the right 'set' and if the material is really understandable, than the meaningful learning can occur. In reality, the student is able to relate what is being presented. On the other hand the concept attainment model helps to attain the concept meaningfully.

Considering these points of meaningful Chemistry learning, two orientation programmes were designed with the objectives mentioned below—

Objectives of Orientation Programmes

1. To provide instruction to Chemistry teachers teaching at +2 stage, in-Advance Organiser model for Chemistry teaching as well as concept attainment model.
2. To identify the selected topics in Chemistry at +2 stage where the two said models could be used.
3. To determine the efficacy of A.O. model in Chemistry teaching as well as the concept attainment model.
4. To prepare model lesson using A.O. model and concept attainment model in Chemistry teaching.
5. To formulate selected instructional material for use of these models.

In order to achieve these objectives, we planned so as to fulfil the basic requirements of the teacher, who has been envisaged as a 'facilitator' of learning in the new education policy.

We are thankful to NCERT for the help provided to us in organising these programmes for the benefit of Chemistry teaching. We also wish to record our thanks to Dr. P. K. Khanna, Principal, RCE, Bhopal, Dr. J. S. Grewal Dean of Instruction and Prof. G. K. Lehri, Head, Deptt. of Science and coordinator Extension services Centre of College for their help and guidance. We are also thankful to Madhya Pradesh, Gujarat, Maharashtra and Goa, State Government education department for deputing the teachers for attending this Orientation Programmes. Suggestions for the improvement of the material are most welcome.

AUTHORS

C O N T E N T S

Chapter	Pages
1. Cognitive Function and the Role of Organizers	1
2. Types of Advance Organizers	9
3. A Model Lesson Using Advance Organizer Model	11
4. A Model Lesson Using Advance Organizer (A.O.) Model	15
5. A Model Lesson Using A.O. Model	23
6. A Model Lesson Using Advance Organizer Model Topic Covalent bond	27
7. A Model Lesson Using Advance Organizer	32
8. A Model Lesson Using Advance Organizer	38
9. Appendix—I	45
10. Concept Attainment Model	49
11. Theory Checkup for the Concept Attainment Model	53
12. Model Lesson in Chemistry On Concept Attainment Model Reception Oriented Model—Ionophores	63
13. Model Lesson in Chemistry On Concept Attainment Model Selection Oriented Model—Basicity of oxoacids	67
14. Model Lesson in Chemistry On Concept Attainment Model Reception Oriented Model—Enthalpy of Formation	71
15. Model Lesson in Chemistry On Concept Attainment Model Reception Oriented Model—Arrhenius Acids	75
16. Model Lesson in Chemistry On Concept Attainment Model Selection Oriented Model—Amines and their Basic Behaviour	79
17. Appendix—II	83
18. Bibliography	84

PART I

ADVANCE ORGANIZER MODEL

Cognitive Functioning And The Role of Organisers

— S. N. Tripathi

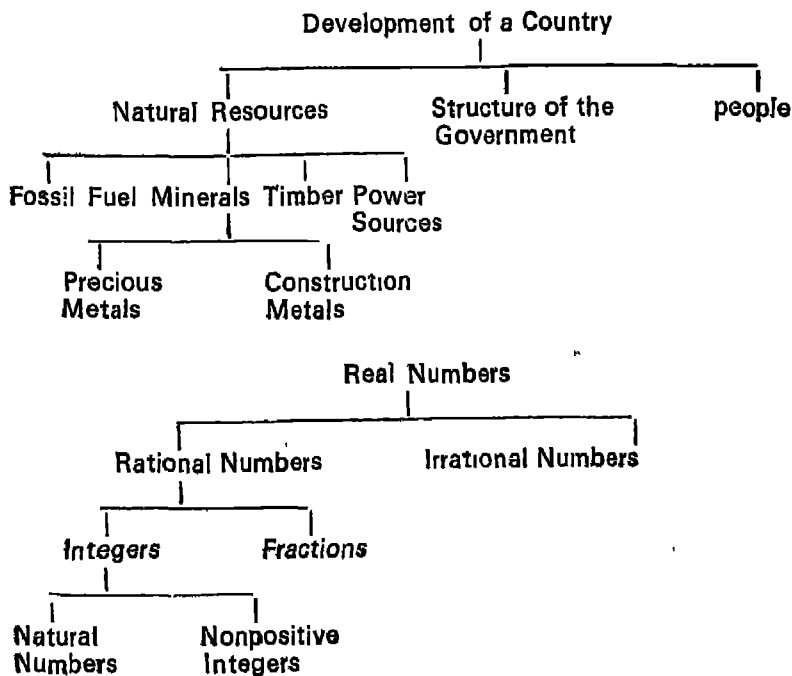
Knowledge, in order to be retained and effectively used, must be organized. Unrelated facts are likely to be forgotten. But if these facts are subsumed under broader concepts and principles they are likely to be better retained and used when a need arises. Ausubel has suggested the use of broad principles in order to achieve a better organization of knowledge.

Principles of Cognitive Functioning :

Ausubel has emphasized two important principles of cognitive functioning. These are :

1. progressive differentiation, and
2. integrative reconciliation

Progressive Differentiation : Progressive differentiation means organization of the cognitive structure in the form of a hierarchy. At the top is placed a concept or principle which is broad in its interpretation and is more inclusive. Under this are included concepts and principles which are more specific and less inclusive. These are followed by still more specific concepts and principles. Thus a hierarchy beginning with a very broad concept or principle to concepts and principles which are specific is developed. This is called progressive differentiation of knowledge. Below are given a few examples of hierarchical organization of knowledge.



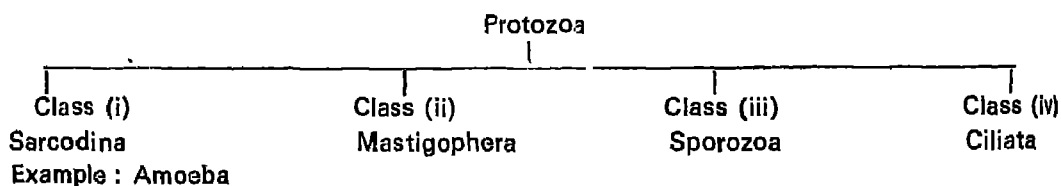
The above examples show how knowledge is organised in a hierarchical manner. Generally this kind of organization is already available in the textbooks. An arbitrary structure can also be developed unless it is inconsistent with the recognized view.

A teacher who is teaching a subject already has a hierarchical structure of knowledge of that subject in his mind. A chemistry teacher has the structure of periodic table. A zoology teacher knows the classification of the animal kingdom. When he has to talk about amoeba he knows that it belongs to Phylum Protozoa. He knows about the general characteristics of this phylum and can relate the study of amoeba to these general characteristics. The student should also be able to do the same. If the student does not relate amoeba to the general characteristics of the phylum protozoa, then he is likely to forget some of the facts that he studied about amoeba or he will not be able to understand their full significance.

Development of hierarchical structure of knowledge has been called 'progressive differentiation'. This progressive differentiation is achieved through generalizations. Let us take the generalization about protozoa.

The phylum protozoa comprises animals which have a single cell or a colony of cells, similar in structure and performing all functions of life independently of each other.

This generalization would help in the organization of knowledge. If we have to teach our students about amoeba, we have to first explain to them the phylum protozoa. This generalization will come in the very beginning. This is what is known as advance organizer. Organizer means that it organizes the knowledge. The adjective 'advance' means that it should come in the beginning.



Integrative Reconciliation : When we are studying a subject we come across two or more topics in which there are some similarities and some differences. Students will find such topics very confusing unless the teacher tries to reconcile and integrate them. Hence the term 'integrative reconciliation', has been used. This is the second principle of organization of knowledge.

In history when the students study about Jainism and Buddhism, they find it a little confusing. There is so much similarity between the two that it becomes difficult to differentiate between them. There is no confusion in the mind of the teacher. She clearly sees the difference between the two. She should also enable the students to see these

differences. How can she do it? Here again, she has to give some generalization in the beginning highlighting the basic similarities and differences, especially the difference between Buddhism and Jainism. Then she can take up a more detailed study of Buddhism and Jainism. Since the students already know the main differences they will not feel confused and the knowledge will be properly organized. Suppose the teacher says, "Jainism laid too much emphasis on penance [Tapasya] and puritanical life, while Buddhism recommended the middle path. Buddhism does not want that a person should put himself to needless suffering". This would be a comparative organizer and would bring out the difference between Buddhism and Jainism. After understanding this the student can study the main teachings of both the religions and he will not feel confused.

Use of Organizers :

In order to facilitate learning, we should organize teaching in such a manner that there is progressive differentiation of knowledge. Often the subject matter is arranged in this form. If this be the case, it would be necessary to repeatedly draw the attention of the students to the broader concepts so that the subsidiary concepts are viewed under a proper perspective. Whenever these broader concepts are lacking, the teacher may try to formulate them. Such broad concepts or generalizations have been termed as organizers by Ausubel. Usually organizers are verbal. They can also be perceptual. A diagram or a chart can function as an organizer. Verbal organizers can be of two types :

1. Expository Organizer
2. Comparative Organizer

Expository organizer is used when the teacher wants to bring about progressive differentiation of knowledge.

Comparative organizer is used to bring about integrative reconciliation.

What is an advance Organizer ?

Ausubel has defined advance organizer. His definition is given below :

An advance organizer is introductory material that is presented ahead of the learning task and is at a higher level of abstraction and inclusiveness than the learning task itself. Its purpose is to explain, integrate and interrelate the material in the learning task with previously learnt material (also to help the learner discriminate the new material from previously learnt material).

The most effective organizers are those that use concepts, terms, and propositions that are already familiar to the learner as well as appropriate illustrations and analogies.

Advance organizers are generally based upon the major concepts, propositions, Generalizations principles, and laws of a discipline.

Weil and Joyce in Information Processing Models of Teaching, have given some guidelines for formulating the advance organizer.

An organizer should :

1. be at a higher level of abstraction, generality, and inclusiveness than the learning material;
2. explore the essential features of the concept (or proposition);
3. overview all major similarities and differences between issues and new ideas before they are encountered;
4. provide examples;
5. link the students' previous background or experience to the organizer;
6. emphasize the terminology of language of the concept or proposition.

Expository Organizer on Landscape :

In geography unit we read about several different rural landscapes. But first we need to know what a landscape is.

Look out of the window. How far can you see ? Two miles ? One mile ? A half mile ? Not very far. As person can see a tiny part of earth at one time.

You see a landscape through the window. A landscape is that part of the earth you can see and look over. When you drive along the highway, you see many different landscapes.

- (a) What is a landscape ?
- (b) How large is the landscape of an ant ?
- (c) How large is the landscape of an astronaut orbiting the earth ?
- (d) Can we say that landscapes vary in size ?

Comparative Organizer on Landscape :

There are two types of landscapes. They are urban landscape and rural landscape. An urban landscape is what we see in the city. Urban means city. An urban landscape has tall buildings, crowded side-walks, express ways, factories, and many different types of houses. We see many different landscapes when we drive in a city.

Rural landscape refers to open country and farming. Every landscape that is not in a city is a rural landscape. Some rural landscapes are made of farms and farm villages. Other rural landscapes are forests.

- (a) Does a rural landscape differ from an urban landscape ?
 - (b) Which type of landscape do you see through the classroom window ?
1. Organizer is at a higher level of abstraction and generality.
 2. The essential features of the concept or proposition must be pointed out and explained.

Syntax :

There are three phases in this model.

Phase One : Presentation of an Advance Organizer.

Phase Two : Presentation of learning task or material.

Phase Three : Strengthening cognitive organization

Phase one : Presentation of Advance Organizer

Clarify aims of the lesson

Present organizer

Identify defining attributes

Give examples

Provide context

Repeat

Prompt awareness of learner's relevant knowledge and experience.

Phase Two : Presentation of Learning Task or Material

Make organization explicit

Make logical order of learning material explicit

Maintain attention

Present material.

Phase Three : Strengthening Cognitive Organization

Use principles of integrative reconciliation.

Promote active reception learning

Elicit critical approach to subject matter.

Clarify.

PLANNING GUIDE FOR ADVANCE ORGANISER MODEL

PHASE ONE : PRESENTATION OF ADVANCE ORGANISER

Stating Aim of the Lesson

"We talked about...last week, and today we want to discuss...and major...and the the chief difference between...and..."

Aim can be stated in a number of ways :

- (i) giving the topic as title.
- (ii) stating a generalisation.
- (iii) making a statement.
- (iv) summarizing the main points.
- (v) defining the objectives.
- (vi) asking students about related topics
- (vii) or using a combination of these strategies

Planning Advance Organiser

(1) Identify the concepts, proposition, or principle on which the advanced organiser will be based.

(2) Will the Advanced Organizer be an expository or comparative organizer ?

(3) Describe or explain the essential characteristics or features of the Advance Organizer.

(4) Give several examples of the idea in the Organizer.

(5) Describe major similarities and differences between existing ideas and new information.

(6) Formulate the Advance Organizer presentation.

An Organizer should :

- 1. be at a higher level of abstraction, generality and inclusiveness than the learning material ;
- 2. explore the essential features of the concept (or proposition) ;
- 3. overview all major similarities and differences between issues and new ideas before they are encountered ;
- 4. provide examples ;
- 5. link the students previous background or experience to the organizer.
- 7. emphasize the technology or language of the concept or proposition.

PHASE ONE : SUMMARY OF ACTIVITIES

Clarify aims of lesson

Present organizer :

Identify defining attributes.

Give examples.

Provide multicontext (different types of examples).

Repeat terminology of subsumer (organizer).

prompt awareness of relevant knowledge and experience in learner's background.

PHASE TWO : SUMMARY OF ACTIVITIES

- Presentations of Learning Task or Material
- Make organization explicit.
- Make logical order of learning material explicit.
- Maintain attention.
- Present Material.

Planning Phase Two :

7. Briefly Describe the learning task and the nature of the new learning material.
8. List two behavioural objectives that you will teach for this lesson.

PHASE THREE : STRENGTHENING ORGANISATION

Clarification of Integrative Reconciliation, Active Reception Learning and Critical Approach

There are several ways to facilitate integrative reconciliation of the new material

Ways to Facilitate Integrative Reconciliation

1. remind the students of the whole cognitive organisation (the larger picture)
2. ask for a summary of the major attributes of the new learning material ;
3. repeat precise definitions ;
4. ask for differences between parallel subsumers (organizers)
5. ask students to describe how the learning material supports the concept or proposition that is being used as a subsumer.

Ways to Promote Active Reception Learning

1. asking students to describe how the new material relates to a single aspect of their existing Knowledge ;
2. asking students for additional examples of the concept or proposition in the learning material ;
3. asking students to verbalize the essence of the material, translating it into their own terminology and personal frames of reference ;
4. asking students to examine the material from alternative points of view ;
5. relating the material to contradictory material, experience, or knowledge.

Ways to Develop a Critical Approach to Knowledge

1. asking students to recognize assumptions or inferences that may have been made in the learning material ;
2. to judge and challenge these assumptions and inferences ;
3. to reconcile contradictions among them.

SUMMARY OF ACTIVITIES OF PHASE III

Use principles of integrative reconciliation (integration of new material with what the students already know).

Promote active reception learning.

Elicit critical approach to subject matter.
Clarify.

Planning Phase Three: Active Reception Learning

(9) Describe how you plan to use skills for promoting active reception learning (asking for examples of the concept or proposition in the new material ; relating new material to existing knowledge and personal experience ; translating new material into students own terminology or frame of reference).

Promoting a Critical Approach

- (10) What inferences or assumptions are made in the learning material ?
- (11) How will you explore these in your presentation ?

Strengthening Cognitive Structure

- (12) The basic activities you will use to strengthen cognitive structure are : (to be completed by the teacher)
- (13) Describe which one(s) of these you will concentrate on in your lesson, and how will you go about doing it.

Types of Advance Organizers

Dr. I P. Aggarwal
Deptt. of Science,
Regional College of Education
Bhopal

For practicing the advance organizer model in teaching of chemistry, the first and the foremost task for the teacher is to select the organizers and word them properly. While selecting the organizer, the teacher should scrutinize very minutely that the organizer should include the learning material in it. Few organizers discussed with the participants (of the workshop held at RCE, Bhopal from 15-8-88 upto 21-8-88) and finalized are as follows.

1. Expository Type

A. Concept Definition

- (i) Compounds may contain several elements but compounds containing carbon and hydrogen only are known as hydrocarbons.
- (ii) A chemical bond can also be formed by overlapping of atomic orbitals and the bond thus formed is known as the covalent bond.
- (iii) All interactions do not result in hydrolysis, only such ion-solvent interactions result hydrolysis in which the $H-O-H$ bonding of water is broken.
- (iv) Before a species gets a particular shape, electronic waves of the orbitals re-adjust themselves and cause hybridization.
- (v) Realignment of electrons between the reacting species is the cause of chemical change and one such change is redox reactions.

B. Generalization

- (i) Stress of any kind on the equilibrium shifts the equilibrium in a direction opposite to the stress applied.
- (ii) Decrease in the free energy of the system is the driving force for the feasibility of occurrence of a change.
- (iii) A hydrogen bond is formed whenever hydrogen is trapped between two highly electronegative elements but only inter-molecular hydrogen bonding influences the melting and boiling points of the substances.

2. Comparative Type

- (i) Changes may conveniently be classified into spontaneous and non-spontaneous ones, electrolysis is that type of non-spontaneous redox change which occurs at the expense of electrical energy.
- (ii) Peroxides are that class of oxides, which in addition to the element oxygen linkage, contain O—O linkage.
- (iii) Oxo-acids are ionogen type of electrolytes in which basicity of the acids is determined by H—O linkages present in the molecule.

A Model Lesson Using Advance Organizer Model

Dr. I. P. Aggarwal
Deptt. of Science
Regional College of Education
Bhopal

Phase 1. Topic : Metallurgical Extractions

(i) Aim

The socio-economic condition of the society is related to the industrial development, which in turn is linked with the new technologies available for metallurgical extractions. Metals are thus our great friends. The science of winning the metals from the compounds in which they occur in nature is called metallurgy. It is one of the oldest branches of chemical knowledge but one to which new discoveries are constantly being added and need to be added for the prosperity of humanity.

(ii) Defining the Advance Organizer

Metals are won in the pure form through reduction of their compounds, whereas active metals because of their tendency to act as very good reducing agents are extracted electrolytically, noble metals are usually extracted first by complexing them.

Teacher Which block of the elements in the periodic table acts as very good reducing agents ?

Student 'S' Block elements.

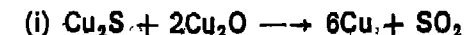
Teacher Good. Now which block of the elements are available in abundance and tend to form complexes ?

Student d-Block elements.

Teacher Very good. Today we will proceed to discuss the extraction of these families.

(iii) Prompting Awareness of Learner's Knowledge

Teacher Study the following reactions and find out the common generalization.



Student Metals are obtained in the native state through reduction of their compounds

Teacher Yes ! Now can you name some precious metals ?

Student Gold and silver.

Teacher That's right.

Teacher What happens when the precipitate of silver chloride is dissolved in Ammonia?

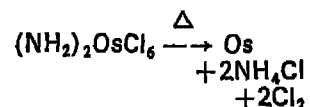
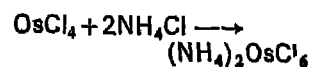
Student $\text{AgCl} + 2\text{NH}_3 \rightleftharpoons [\text{Ag}(\text{NH}_3)_2]^+ + \text{Cl}^-$

Teacher Good, Silver here is present in the complex form. In which ammonia is acting as the complexing agent. Today we shall discuss about the extraction of Ag, Au, Pt, Os (Noble metals) etc. from their ores and that of certain active metals like Na, Mg, Ca etc.

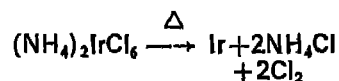
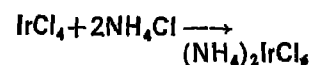
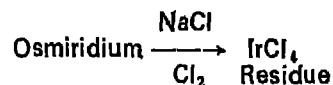
Phase 2. Presentation of Learning Material

Teacher directs the students to examine critically the following reactions in each case of the metallurgical extraction.

Metal	Ch. of ore	Main method of Extraction	Equation for Extraction
(i) Lithium	Spodumenne, $\text{LiAl}(\text{SiO}_3)_2$	Electrolysis of fused LiCl with KCl added	All involve electrolytic reduction $\text{Mn}^{++} + \text{ne}^- \rightarrow \text{M}$
(ii) Potassium	Carnallite, $\text{KCl}, \text{MgCl}_2, 6\text{H}_2\text{O}$	Electrolysis of fused KCl with CaCl_2 added	
(iii) Sodium	Rock Salt NaCl	Electrolysis of fused NaCl with CaCl_2 added	
(iv) Magnesium	Carnallite, $\text{KClMgCl}_2, 6\text{H}_2\text{O}$	Electrolysis of fused MgCl_2 with KCl added	
(v) Aluminium	Bauxite, $\text{Al}_2\text{O}_3, 2\text{H}_2\text{O}$	Electrolysis of Al_2O_3 in molten Na_3AlF_6	
(vi) Silver	Argentite, Ag_2S	Special methods involving use of complexing agent	$\text{Ag}_2\text{S} + 4\text{NaCN} \rightarrow 2\text{Na}[\text{Ag}(\text{CN})_2] + \text{Na}_2\text{S}$ $2\text{Na}[\text{Ag}(\text{CN})_2] + \text{Zn} \rightarrow 2\text{Ag} + \text{Na}_2\text{Zn}(\text{CN})_4$
(vii) Gold	Occurs as metal	...do...	$4\text{Au} + 8\text{NaCN} + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{Na}[\text{Au}(\text{CN})_2] + 4\text{NaOH}$ $2\text{Na}[\text{Au}(\text{CN})_2] + \text{Zn} \rightarrow \text{Na}_2[\text{Zn}(\text{CN})_4] + 2\text{Au}$
(viii) Platinum	Spertylite, PtAS_2 Platiferrous Sand	...do...	Aqua Platiferrous Sand $\xrightarrow{\text{regia}} \text{H}_2\text{PtCl}_6$ $\text{H}_2\text{PtCl}_6 + 2\text{NH}_4\text{Cl} \rightarrow (\text{NH}_4)_2\text{PtCl}_6$ $(\text{NH}_4)_2\text{PtCl}_6 \xrightarrow{\Delta} \text{Pt} + 2\text{NH}_4\text{Cl} + 2\text{Cl}_2$
(ix) Osmium	Osmiridiumnative alloy	...do...	$\text{Osmiridium} \xrightarrow[\text{Cl}_2]{\text{NaCl}} \text{OsCl}_4 \text{ (vapours)}$



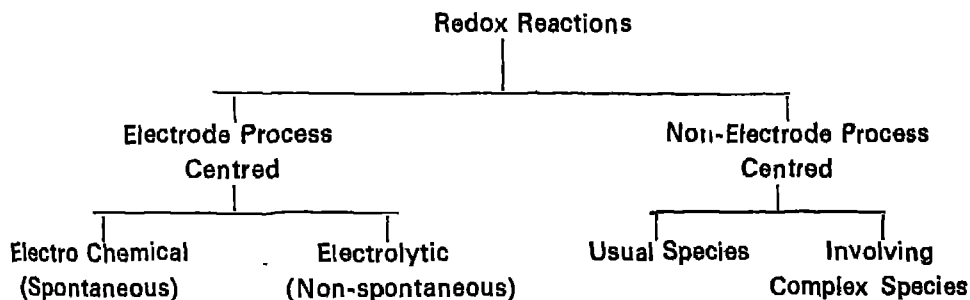
(x) Iridium Osmiridium native alloy Special methods involving use of complexing agent



Teacher at this stage through discussion brings home the fact that usual chemical reduction of active metals is not easy because these metals tend to remain as ions largely, however, their reduction is possible electrolytically because the non-spontaneous change that the electrolysis is. He further compares and contrasts the two board processes of metal extractions and impresses upon the point that all metallurgical extractions are primarily redox changes.

Phase 3. Strengthening of Cognitive Organisation

Teacher—Look at the following picture :



Teacher Now, what do you conclude from the above chart ?

Student Metallurgical reactions involving reduction of the complex species to respective metals is only one category of the redox reactions.

Teacher That's right. List out the conditions that favour formation of complexes.

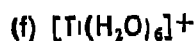
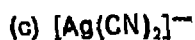
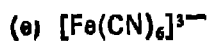
Student These conditions seem to be -

- Stability of the complexing species formed.
- Effectiveness of the complexing species, known as ligand species to interact with cations possessing high positive surface charge density
- Availability of vacant orbitals on the central metal atom to accommodate these ligand species.

Teacher Shakes his head in agreement.

Teacher Boys in the metallurgical extraction of Ag, Au, Pt, Os and Ir you have come across with cation and anion complexes, let us study how these are named, Teacher clarifies the procedure adopted for naming the cation and anion complexes and further assigns the following exercise to his students.

Teacher Name the following complex ions



Student -

(a) Tetra-ammine Zinc(II) ion

(d) Hexa-ammine Cobalt (III) ion

(b) Hexafluoro ferrate (III) ion

(e) Hexa-cyano Ferrate (III) ion

(c) Dicyano Argentate(I) ion

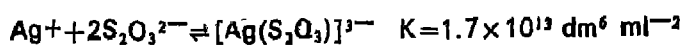
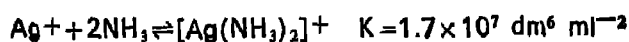
(f) Hexa-aquo titanium (I) ion

Promoting Active Reception Learning

1. Magnesium and aluminium are frequently employed for the extraction of metals such as Mn, Cr and Co from their respective oxides. What is the principal reason why these metals are used as reducing agent ?
2. How may magnesium be extracted from sea water ? Write all chemical reactions.
3. What favours d-block elements to form complexes easily ? Name two cations other than d-block elements capable of forming complexes easily.

Developing Critical Approach to Knowledge

Teacher Could you guess why in the extraction of silver this is being complexed as cyanide complex ? He at this stage presents the following data to the students



Student This is so because with cyanide it forms a stable complex.

Teacher Good. In silver plating we use potassium argentocyanide. What do you infer from this ?

Student Reduction of complex species is possible electrolytically also.

Teacher Excellent, it seems that you people have picked up my idea,

A Model Lesson Using Advance Organiser (A. O.) Model

— Dr. S. P. Saksena

Topic : Types of Organic Reactions

Phase—I

(i) Aim

A chemical reaction involves transformation of one kind of matter into the other in organic reactions transformation of reactants to products takes place through some definite steps. These steps give us information regarding the sequence of breaking and making of bonds. The description of these steps give us information regarding the mechanism of the reaction.

(ii) Definition of A. O.

The species carrying a positive charge tend to attack a molecule at the point of high electron density, while species carrying a negative charge tend to attack a molecule at a point of low electron density, these attacks help the reaction to proceed to completion.

Teacher—We know that methane and chlorine under the influence of heat or light, form methyl chloride and hydrogen chloride.

How is a molecule of methane converted into a molecule of methyl chloride? Does this transformation involve more than one step if so, what are these steps?

Student—The conversion of methane into methyl chloride involves the following steps.

(1) Initiation (2) Propagation and (3) Termination

Teacher—Does the nitration of benzene by a mixture of concentrated nitric acid and concentrated sulphuric acid take place in one step?

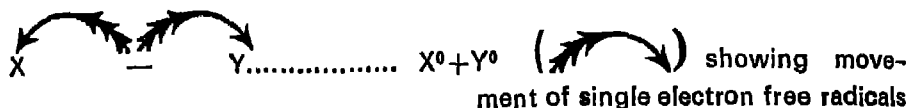
Student—No, it takes place in various steps.

Teacher—Let us discuss today, the mechanism of organic reactions involving different steps.

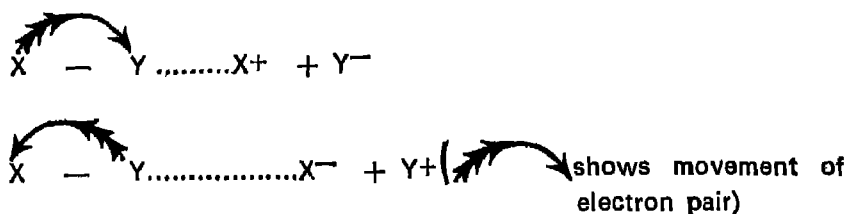
(iii) Prompting Awareness of Learner's knowledge

Teacher—Consider the following situations in order to understand, which bond in the molecule is likely to be broken for the reaction to take place.

i) **Homolytic fission**— The covalent bond joining the atoms X and Y breaks in such a way that each fragment carries one unpaired electrons.



ii) **Heterolytic fission**— The covalent bond breaks in such a way that a pair of electrons stay on any one of the atoms.



Can you name the types of reagents, which bring about heterolysis ?

Student—These reagents are called nucleophiles and electrophiles

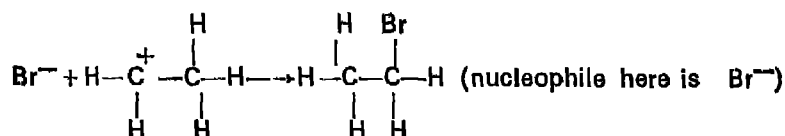
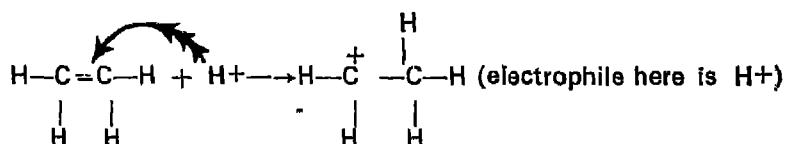
Teacher— Can you name some nucleophiles and electrophiles ?

Student— The nucleophiles are RO^- , HO^- , CN^- , NH_3 , H_2O , ROH and electrophiles are as H^+ , H_3O^+ , NO_2^+ , BF_3 , ZnCl_2 , AlCl_3 .

Teacher— Points out to the student that nucleophile reacts at a positive or positive site and alkoxides or hydroxide ions have more nucleophilicity than neutral substances, which is enhanced by the presence of electron donating substituents eg. alkyl group. He also compares that an electrophile also reacts at a negative or partially negative site and the positive charged electrophiles are more reactive than the neutral ones. He further informs the students that a electron withdrawing substituents tend to concentrate positive charge on the reacting site of the electrophile.

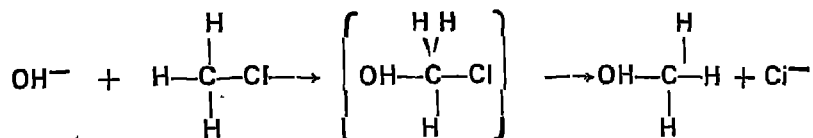
Teacher— Can you give sequence for electrophilic reaction ?

Student— These can be represented as :

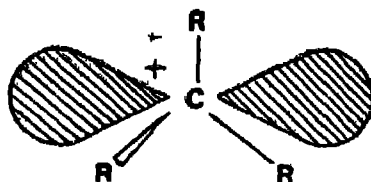


Teacher Give the sequence for the attack of nucleophile such as hydroxide ion on methyl chloride.

Student This can be written as follows :

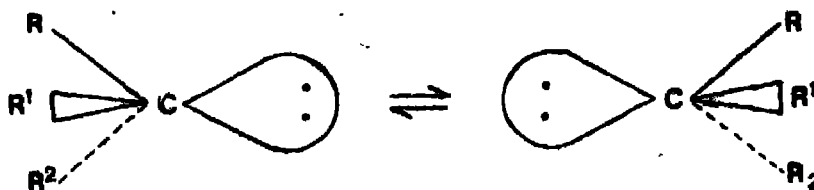


Carbocations Organic species which have a carbon atom bearing only six electrons are called carbocations. The carbon atom here is Sp^2 hybridized and it uses the three hybrid orbitals for single bonding to three substituents, the remaining orbital is empty. This has a flat structure, having all the three covalent bonds in one plane with bonding angles of 120° . This can be represented as;



orbital picture of carbocation

Carbanions These are anions of carbon generated by the removal of one of the groups attached to a carbon without the bonding electrons. Thus every carbanion possess one lone pair of electrons and three pairs of bonding electrons around the central carbon atom which is Sp^3 hybridized.



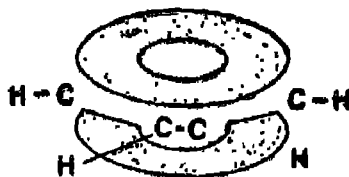
orbital picture of carbocation

You are aware that the reactions of benzene involve substitution, in which the resonance stabilized ring system is present.

What kind of reagents bring about this substitution, and what is the mechanism by which these reactions take place ?

Above and below the benzene plane, there is a cloud of pi-electrons. Because of resonance, these pi-electrons are more involved in bonding together carbon nuclei than are the σ -electrons of a carbon-carbon double bond. Still, in comparison with σ -electrons, these pi-electrons are loosely held and are available to a reagent that is seeking electrons.

It is not surprising that in its typical reactions, the benzene ring serves as a source of electrons eg a base.



Benzene ring pi cloud is source of electrons

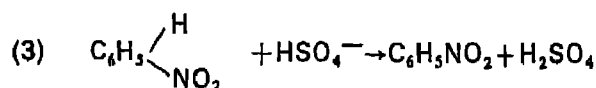
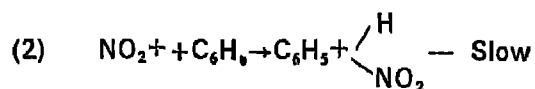
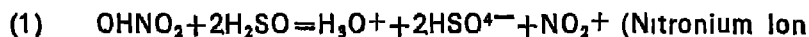
Benzene ring pi- electron cloud is source of electrons.

The compound with which it reacts are deficient in electrons, that is, **electrophilic** reagents or acids. So the typical reactions of benzene ring are electrophilic substitution reactions.

Teacher Are these reactions characteristic of benzene only or of the benzene ring ?

Student These reactions are characteristic of not only of benzene itself, but of the benzene ring where ever it is found—and indeed of many aromatic rings, benzenoid and non—benzenoid.

Teacher Let us begin with nitration, using benzene as aromatic substrate. Sequence of reactions are as;



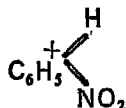
In step (i) nitronium ion is generated, which is the electrophilic particle that attacks the benzene ring.

Teacher What type of equilibrium is shown by reaction (i) above ?

Student The reaction is simply an acid base equilibrium. In this sulphuric acid serves as the acid and nitric acid serves as a base. We may consider that the very strong acid, Sulphuric acid causes nitric acid to ionize in the sense, $\text{HO}^- \dots \dots + \text{NO}_2$ and not the type $\text{H}^+ \dots \dots \text{ONO}_2^-$

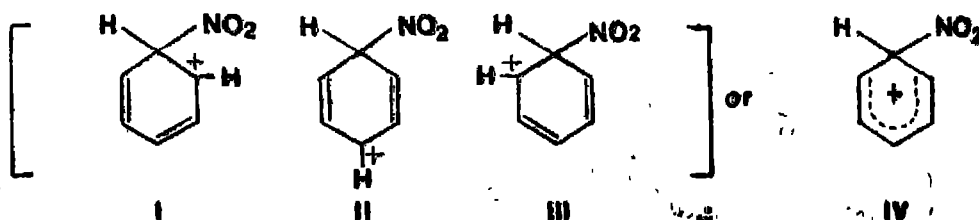
Teacher The nitronium ion needs electrons, where does it find them ?

Student It attaches to one of the carbon atoms by a covalent bond. This forms the carbocation as;



Teacher What is the structure of this carbocation ?

Student We can represent it by three structures I, II, III that differ only in position of double bonds and positive charge.

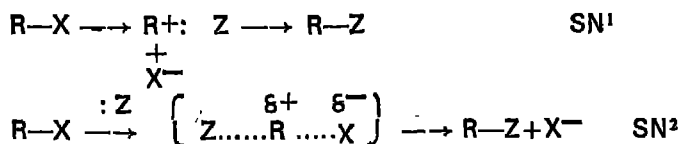


Teacher This means that the positive charge is not localized on one carbon atom, but is distributed over the molecule. The dispersal of the positive charge over the molecule by resonance makes this ion more stable than an ion with a localized positive charge. The hybrid carbocation is also represented by (IV).

The basic ion, HSO_4^- abstracts a hydrogen ion, to yield the substitution product, which retains the resonance stabilized ring. It is the preferred reaction in this case, due to loss of a hydrogen ion.

Nucleophilic Substitution

Teacher explain the nucleophilic substitution reactions as represented below

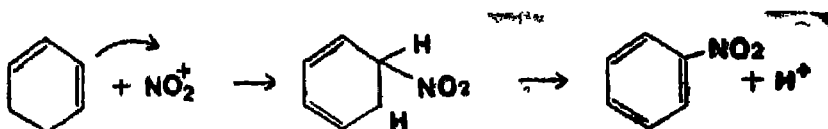


As a result, an SN^1 reaction is favoured by electron release, an SN^2 reaction is relatively insensitive to electronic factor, and nucleophilic aromatic substitution is favoured by electron withdrawal.

Teacher How the nucleophilic substitution reactions can be distinguished ?

Student In nucleophilic substitution, a nucleophile brings an electron pair to the substrate and the leaving group departs with an electron pair.

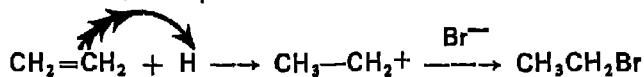
mostly in aromatic systems where the high electron density attracts electrophiles



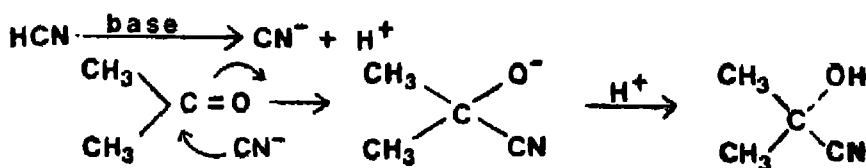
Teacher Can this be related with electrophilic or nucleophilic addition reactions ?

Student An addition reaction is one in which two substances combine to form a single compound. Often the organic compound to which addition takes place contain either a double or triple bond.

In electrophilic addition, a positive species approaches a double bond and forms a bond by converting the pair of electrons into a sigma-bond. The resultant carbocation then combines with a nucleophile as :



In nucleophilic addition, a nucleophile brings a pair of electrons to a carbon atom joined by a multiple bond. The electrons of the multiple bond are then forced to the adjacent atom as :

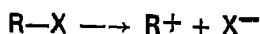


The reaction is complete by the combination of this anion with positive species.

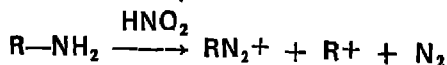
Student How many types of reactions generate carbocations ?

Teacher The carbocations are generated in the following manner.

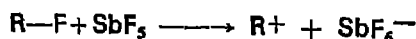
(i) Solvolysis of C—X bond (X = halogens)



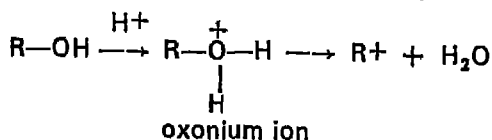
(ii) De-amination of amines by nitrous acid



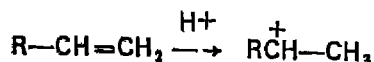
(iii) Reaction of alkyl halides with Lewis acids

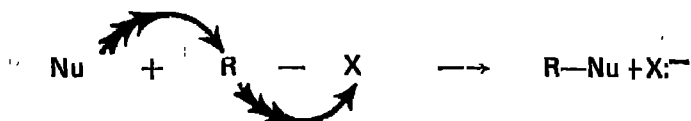


(iv) Protonation of alcohols followed by dehydration



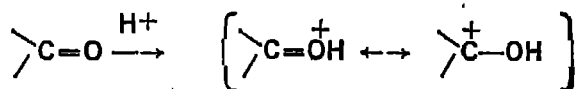
(v) Protonation of alkenes



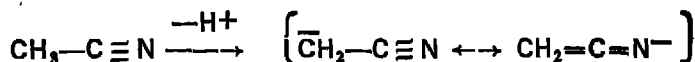
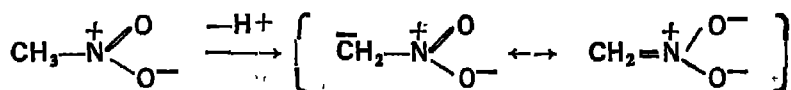


While an electrophilic substitution, the attacking species is an electrophile and the leaving group departs without the pair of bonding electrons. This type of reaction occurs

(vi) Protonation of carbonyl compounds



Teacher The formation of carbanions can be show as :

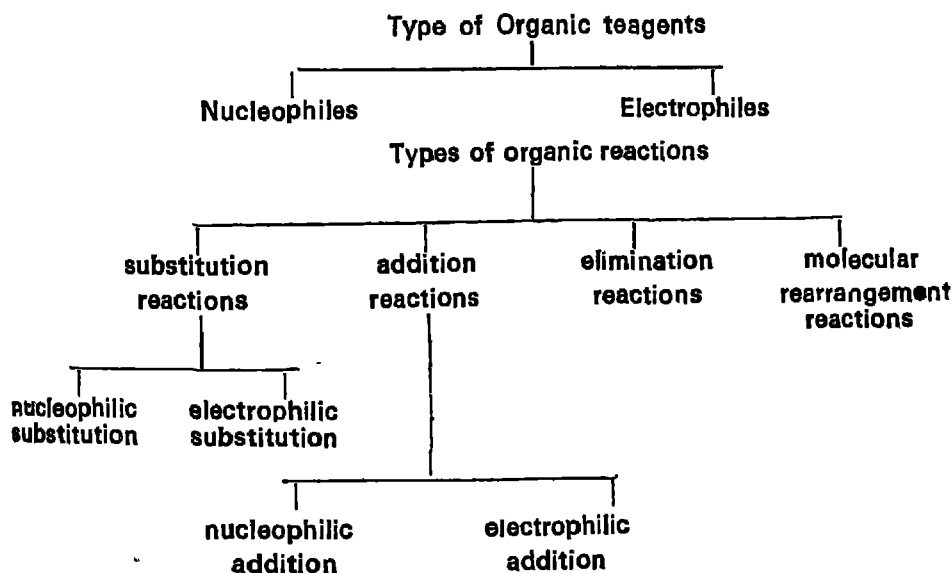


There is little difference of electro-negativities of carbon and hydrogen, the polarity of C—H bond is very small. However the presence of electron attracting substituents such as nitro, cyano or carbonyl groups on the same carbon renders the hydrogen relatively acidic. The increase in acidity is not only due to the electron—withdrawing capacity of these substituents, but also due to their ability to delocalize the negative charge of the anion. Thus hydrogen on the carbon atom alpha to nitro, cyano or carbonyl groups has acidic character and can be removed as protons leaving resonance stabilized anions.

Phase 3 Strengthening the cognitive structure by

Teacher You have studied the types of reagents and the types of organic reactions.

These can be represented as follows :



(ii) Point out the different ways of formulating carbocations and carboanions.

(iii) Define and explain the following terms in about 50 words each :

1. Electrophilic addition reaction
2. Nucleophilic addition reaction
3. Nucleophilic substitution reaction
4. Electrophilic substitution reaction

(iv) How do SN^1 and SN^2 reactions differ ?

promoting active reception learning

(i) How is the chemistry of Lucas test related to the stability of carbocation ?

(ii) Electrophiles are Lewis acids whereas nucleophiles are Lewis bases. Explain how

(iii) Why does addition of HBr to $CH_3CH=CH_2$ proceed through a different mechanism in the presence of organic peroxides ?

Developing critical approach to subject matter

Is SbF_5 also an electron deficient species like BF_3 ? If not then how does SbF_5 act as electrophile ?

A Model Lesson using A.O. Model

Topic : Electrochemical Cells

Contribution made by Participants

Phase 1

(i) Aim :

A reaction in which electrons are released by the species is known as oxidation and the one in which the electrons are gained is known as reduction. Spontaneous redox reaction can therefore be used to produce electric current, which is flow of electrons. This forms the basis of electrochemical cell available in the market in the name of dry cell and certain rechargeable cells also. The future technology regarding dry cells Add rechargeable cells rests on choosing appropriate reducing and the oxidising materials.

(ii) Defining the Advance Orgaizer

Changas may conveniently be classified into spontaneous and non-spontaneous ones. Due to spontaneous redox reaction in a cell there will be generation of electrical energy.

Teacher at this stage explains that spontaneous processes occur with the help of external agents. He cites that the flow of water from the top to the bottom is a spontaneous process whereas the reverse of it (carried out with the help of a machine) is a non-spontaneous one.

Teacher What happens during paddling of a cycle ?

Student Muscle energy is converted into mechanical energy.

Teacher Good. What do you mean by hydro-electric work ?

Student Where the electrical energy is produced from the motion of water ?

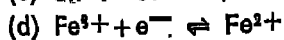
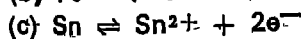
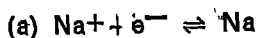
Teacher Excellent. What are thermal plants ?

Student Thermal plants are those plants which produce electrical energy at the expense of thermal energy.

Teacher Fine. What is the source of energy in a cell ?

Student Sir I It may be due to chemical change itself.

Teacher Study the following reactions and state which of them are oxidation and which are the reduction processes :



Student (a) and (d) are reduction processes whereas
(b) and (c) are oxidation processes.

Teacher Good. If Cu and Zn are reacted with any dilute mineral acid, will there be liberation of hydrogen?

Student In case of Cu—no liberation. In zinc hydrogen gas will be liberated (provided Zn is not pure).

Teacher Why?

Student Copper is below hydrogen in the metal activity series and as such hydrogen cannot be displaced by copper and zinc is above hydrogen.

Teacher Today by utilizing this metal activity series, we shall discuss how such cells are designed, which produce electrical energy.

Phase 2— Presentation of Learning Material

(a) **Construction of Daniell Cell :** Daniell cell is one of the examples of electrochemical cell. It can be constructed as follows :

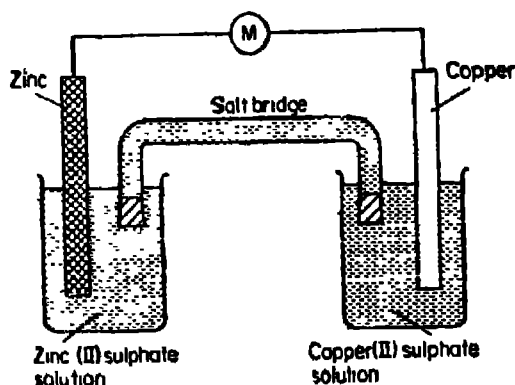
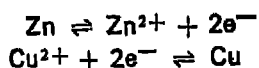
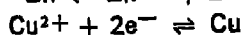


Diagram of a Daniell cell

(b) **Working of Daniell Cell :** As zinc is above copper in activity series, it has more tendency to go into solution, than copper. Hence oxidation will take place at zinc electrode and reduction at copper electrode.



...Oxidation



...Reduction

The redox reaction will be the sum of oxidation and reduction reactions.

i.e. $\text{Zn} + \text{Cu}^{2+} \rightleftharpoons \text{Zn}^{2+} + \text{Cu}$

The flow of electrons will be from zinc to copper through the external circuit.

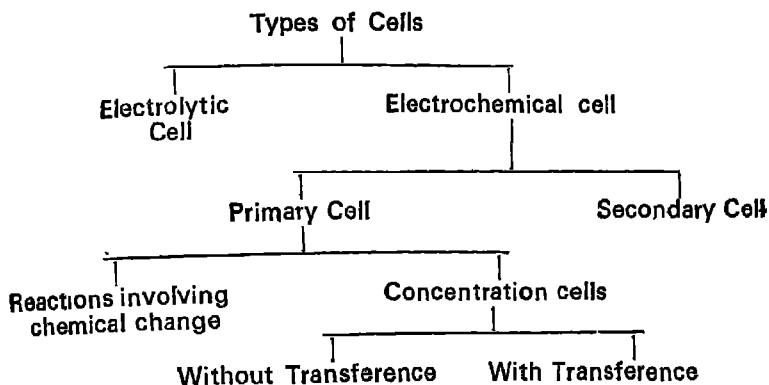
The Daniell cell is an example of a primary cell and its voltage is 1.10 volt at 25°C and with 1 M concentration of each Zn^{2+} and Cu^{2+} ions.

Conventional Representation of Daniell Cell

Here positive and negative signs indicate sign of electrodes.

Phase 3 Strengthening of Cognitive Organization

Teacher Now look at the following representation



(Concentration cells here are being taken as passing reference only. The detailed study about these cells, will be dealt with at higher stage).

Teacher Compare and contrast primary cells and secondary cells.

Student A primary cell is one in which the cell reaction can't be reversed, whereas in secondary cell the cell reaction can be reversed. Both the types of work on the common principle, i.e. electrical energy is produced consequent upon chemical reactions.

Teacher Right. What is the requirement for electric current to flow from one electrode to another?

Student Either there should be difference in the standard electrode potential value of the two electrode system constituting the cell or there should be concentration gradient in the solution of the same electrolyte involved in the cell.

Teacher Very good.

Promoting Active Reception Learning

Teacher A lead storage battery is fitted in an automobile. When does it function as an electrochemical cell and whence as an electrolytic cell?

Student During charging it functions as an electrolytic cell and when fitted in an automobile it functions as an electrochemical cell.

Teacher Very good. Now can you give some additional examples of electrochemical cells.

Student Dry cell and nickel cadmium cell.

Teacher You are right. It is usually said that rusting of iron is an electrochemical change. All of you study rusting of iron in detail and examine it from this angle.

Developing Critical Approach to Knowledge

- (1) If an electrochemical cell is in continuous use, will the emf of the cell increase or decrease? Give reasons in support of your answer.
- (2) Study of the phenomenon of electrochemical cells reveals that pure zinc with dilute hydrochloric acid should liberate hydrogen, yet when two react evolution of hydrogen does not seem to take place. Why?
- (3) Acidified potassium permanganate discharges chloride, bromide and iodide respectively into chlorine, bromine and iodine but does not discharge fluoride into fluorine. How can this inference be counted for, on the basis of electrochemical reactions?

A Model Lesson Using Advance Organiser Model

Topic - Covalent bond

Dr. P. N. Pathak
Regional College of Education,
Bhopal

Phase I

(i) Aim : The properties of the substances depend upon the bonding involved in substances. The Type of bonding in the substances depends upon the physique of atoms as the atoms approach to form the compounds. A covalent bond usually results when two combining atoms have the same or a very little difference in the electronegativity values. In the formation of molecules associated with covalent bonding amongst the atoms the octet rule is obeyed to a very limited extent whereas the departure from the octet rule is observed in a good number of cases. The present lesson is an attempt in this direction.

(ii) Defining the advance organiser :

Covalent bond is formed by sharing of the electron pair/pairs between two atoms leading to the configuration of the nearest noble gas. Whereas the elements of the third period of the periodic table and onward periods expand their valency shell, the elements of the second period only usually obey octet rule.

(iii) Prompting awareness of the prior Knowledge :

Teacher : What are the essential components of our daily life.

Student : Salt, Sugar, Vegetables, fat etc.

Teacher : Yes. What is desired for the combustion of our food.

Student : Oxygen.

Teacher : Good, from where do we get oxygen for our body.

Student : Air.

Teacher : Right, What major gases are present in air ?

Student : Oxygen, nitrogen and carbon dioxide.

Teacher : Yes, What is the formula of oxygen ?

Student : O_2

Teacher How are the two oxygen atoms bonded to each other in dioxygen ?

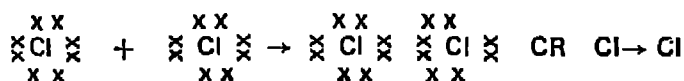
Student No statement

Teacher Now we will like to study the bonding pattern of O_2 , N_2 , CO_2 , Cl_2 etc. in detail.

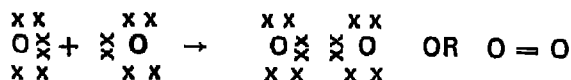
Phase 2 Presentation of Learning material

Covalency In electrovalent bond, as we have studied earlier, transference of one or more electrons from one atom to another takes place, and ions formed have the electronic configuration of the nearest noble gas. It was pointed out by Lewis that in simple molecules another form of bonding had to operate by sharing of electron pair/pairs leading to attainment of stable configuration of a noble gas for individual atom.

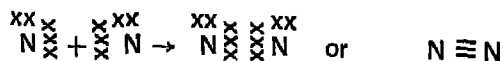
For example consider chlorine atom which has got seven electrons in its outer most shell, If one electron is provided by each atom and shared equally, then each chlorine atom can acquire a share of electron pair leading to a completed octet which may be represented by a single bond.



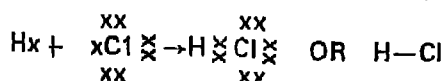
The oxygen atom has six electrons in its outer shell and in oxygen molecule O_2 , a stable electronic configuration can be assumed to be attained by the sharing of 4 electrons, two being provided by each atom. The oxygen atoms are bonded together by a double covalent bond as :



Similarly, the nitrogen molecule contains a triple bond which includes the sharing of six electrons, three electrons being provided by each nitrogen atom.



When the two atoms that are bonded together by covalent bonds are different the electrons are not equally shared. For example, the chlorine atom has a greater affinity for electrons than has the hydrogen atom in hydrogen chloride, and the electron pair constituting the single covalent bond is displaced towards the chlorine atom. The molecule is said to possess an electrical dipole.



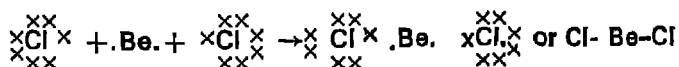
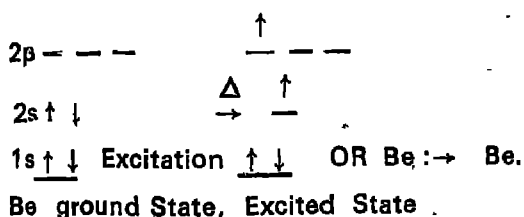
To indicate the presence of an electrical dipole in the molecule the notation



The covalent compounds discussed above exist in the form of discrete molecules with little force of attraction between the individual molecules. They are generally easily volatile liquids or easily fusible solids. There are some giant molecules or macro molecules eg diamond, silicon dioxide, starch and proteins, in which directional covalent bonds extend throughout the whole structure. Such compounds are solids which may have high melting and boiling points.

A perusal of above examples shows that a covalent bond is formed to attain the electronic configuration of noble gas, yet there are many exceptions for example. BeCl_2 , BF_3 , PF_5 , SF_6 , SO_3 and SO_4^{2-} . The modern theory of valency focuses attention of electron pairing rather than on completion of the octet.

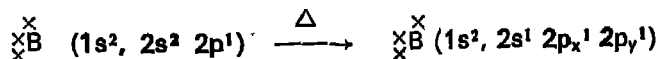
consider BeCl_2 molecule in which beryllium atom has the electronic configuration $1s^2, 2s^2$, (no unpaired electron) and chlorine atom has the configuration $1s^2, 2s^2, 2p^6, 3p^2, 3p^5$ (one unpaired electron) when the beryllium atom enters into chemical combination, an electron from the $2s$ level is promoted to higher $2p$ level with absorption of energy and each single electron is paired off with the unpaired electron of chlorine atom.



Quartet of Electrons

The promotion energy is less than the energy released in forming bonds with the unpaired electrons of the chlorine atom, indeed if this were not so then beryllium would be devoid of chemical properties like the noble gas helium,

The formation of boron trifluoride molecule can be explained in a similar way as.

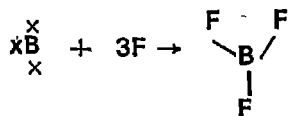


ground state

1 unpaired electron

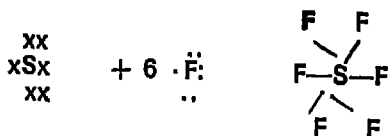
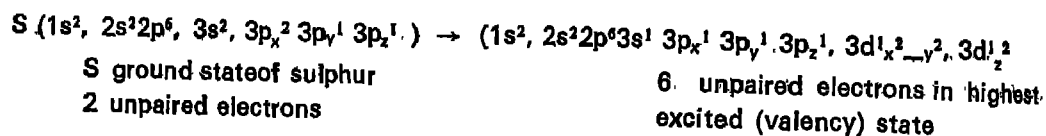
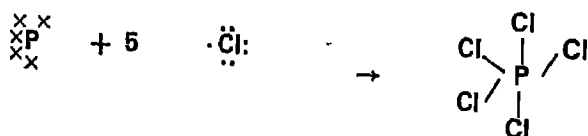
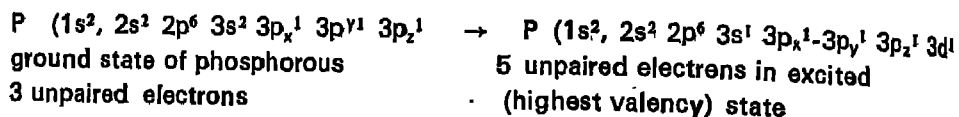
excited state 3 unpaired

electrons



Sextet of electrons

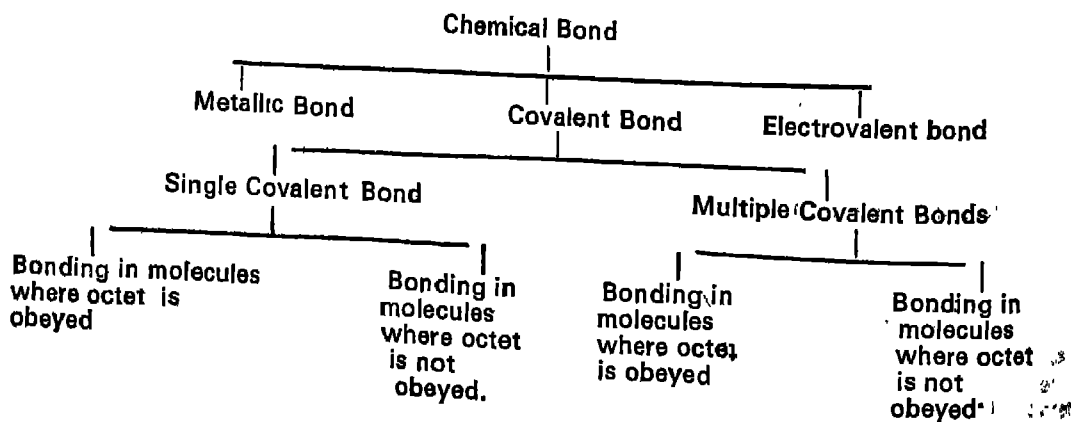
Phosphorous penta chloride PCl_5 and Sulphur hexa fluoride SF_6 are also compounds in which the octet of electrons around the central atoms exceeded. The same reasoning as before applies. Thus 3d levels are available to phosphorous and sulphur which can accommodate electrons promoted from ground state.



phosphorous pentachloride and sulphur hexafluoride can be prepared because the energy released in bond formation with chlorine and fluorine is more than sufficient to produce a phosphorous atom with 5 and sulphur atom with 6 unpaired electrons respectively.

Phase 3 Strengthening of Cognitive Organisation

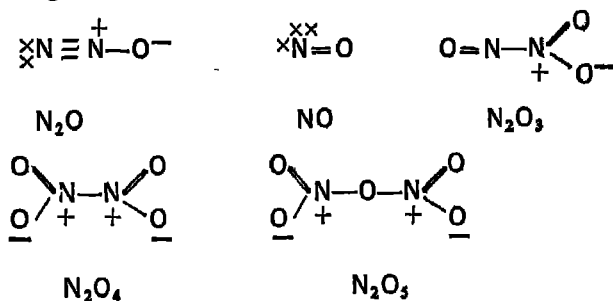
Teacher directs the students to carefully examine the following sequential steps regarding chemical bond:



- Teacher** How would you label SO_3 and CO_2 molecules in the above mentioned set up?
- Student** Both involve multiple bonds, whereas CO_2 molecule obeys octet, SO_3 molecule is example of violation of the octet rule.
- Teacher** That's fine. Now compare and contrast covalent bonding and coordinate bonding.
- Student** Coordinate covalent bond is only a special type of covalent bond in which the one pair of electrons to be shared between two atom is provided by one atom rich in electrons, called donor atom.
- Teacher** Good, Teacher at this stage asks for further examples of the species involving coordinate covalent bond and students provide the same.

Promoting Active Reception Learning

- Teacher** In earlier class, you have known that nitrogen forms five different oxides. Now sketch the bonding in these.
- Student** The bonding in these oxides is as



- Teacher** What is the covalency of nitrogen in N_2O_3 , N_2O_4 and N_2O_5 each?
- Student** It is four.
- Teacher** Give examples of two more species, where nitrogen exhibits covalency four.
- Student** These are NH_4^+ and HNO_3 in vapour state.
- Teacher** Excellent. Now are you in a position to judge why do species like AlCl_3 , FeCl_3 and HgCl_2 act as catalyst in Friedel Crafts reactions.
- Student** This is because they form species respectively of the type AlCl_4^- , FeCl_4^- and HgCl_4^{2-} and increase covalency of the central element Al, Fe and Hg in these cases.
- Teacher** Nods his head in affirmative.

Developing Critical Approach to Knowledge

- Teacher** Fluorine forms species of the type AlF_6^{3-} , SiF_6^{2-} , SF_6 , IF_7 . How is it so that analogous species of chlorine like the AlCl_6^{3-} , SiCl_6^{2-} , SCl_6 and ICl_7 are not found. You may discuss amongst yourself and let me know the answer. After discussion amongst themselves and with the teacher they bring home the points that either energetically or on structural grounds taking into consideration it is not possible to have the species SiCl_6^{2-} , SCl_6 and ICl_7 formed.

A Model Lesson Using Advance Organiser

Contribution made by
Participants

Topic Transitional Elements

Phase I

(i) Aim

Transitional elements are of great importance to all of us. There will hardly be any human being on this earth who does not come across with Iron, Copper, Silver and Manganese in his daily life. Houses in which we live in, make use of iron, Copper wires are used for electrical transmission, silver is used for silvering of mirror, and manganese is used in the manufacture of steel. How is it that these elements can be drawn into thin sheets and wires? What makes copper sulphate to show colour in its hydrated form and what for MnO_4^- is associated with colour whose compound (KMnO_4) we make use of as 'Lal Dawai'. As the properties of representative elements are function of their valence electrons so is the case with transitional elements also but in their case the properties are also function of the number of electrons present in the d- orbitals. The present lesson is an attempt to organise the learning regarding the colour shown by d- block elements in their various compounds.

(ii) Defining the Advance Organizer

The Chemistry of the species is decided by their physique and environs. The colour in case of transitional elements depends upon the number of unpaired electrons present in the d- orbitals of the central metal cation, the nature and the number of interacting ligands with the central metal cation.

Teacher What happens when alkali metals react with water?

Student Hydrogen is produced.

Teacher Do all alkali metals produce hydrogen with same vigour when they react with water?

Student No. They rather react in the order :



Teacher That's right. Now what would happen if sodium is allowed to react with, water, absolute alcohol and melt of phenol.

Student This time the rate of evolution of hydrogen would follow the order :
Alcohol < Water < Phenol

Teacher Good. Now what do you conclude out of it.

Student The chemical reaction is governed by the physique of the reacting species and their environs.

Teacher You know the phenomenon of rusting. What different states of iron we encounter in the entire process of rusting ?

Student Zero, $+2$ and $+3$.

Teacher That's fine. What is the number of unpaired electrons present in d-orbitals in Fe (II) and Fe (III).

Student In Fe (II) it is four but in Fe (III) it is five.

Teacher How do you differentiate between the following two species of iron :
 FeCl_4^- and $\text{Fe}(\text{CN})_6^{4-}$

Student In FeCl_4^- , iron is present in its oxidation state $+3$ whereas in $\text{Fe}(\text{CN})_6^{4-}$ it is present in $+2$.

Teacher That is right, but this is only the partial answer to my question what more information can you draw from these two species ?

Student In FeCl_4^- , the ligand and four Cl^- ligands interact with Fe^{3+} , whereas in $\text{Fe}(\text{CN})_6^{4-}$ six CN^- ligands interact with Fe^{2+} .

Teacher Excellent At this stage he makes the statement that transitional elements are so often coloured, and today we shall study what gives colour to the transitional elements.

Prompting Learner' Prior Knowledge

Teacher I am writing the compounds of certain d-block elements along with colour shown by these.

	Compounds	Colour if any
A	Cu_2Cl_2	Colourless
B	$[\text{Cu}(\text{H}_2\text{O})_4]^{2+} \text{SO}_4^{2-} \cdot \text{H}_2\text{O}$	Blue
C	$\text{K}_4[\text{Fe}(\text{CN})_6]$	Yellow
D	$\text{Fe}[(\text{H}_2\text{O})_6]^{2+} \text{SO}_4^{2-} \cdot \text{H}_2\text{O}$	Light green
E	$\text{CO}[(\text{H}_2\text{O})_6]^{2+} \text{SO}_4^{2-} \cdot \text{H}_2\text{O}$	Pink

Teacher What similarities and dissimilarities you observe in these compounds ?

Student With the exception of Cu_2Cl_2 , rest all are coloured and in the case of coloured compounds, some ligands are always attached with the cation.

Teacher That's right and there offer informs to write the electronic configuration of the following ions.

Zn^{2+} Cd^{2+} , Hg^{2+} , Ag^+ and Au^+

Student Zn^{2+} is (Ar) $3d^{10}$

Cd^{2+} is (Cr) $4d^{10}$

Hg^{2+} is (Xe) $4f^{14} 5d^{10}$

Ag^+ is (Kr) $4d^{10}$

Au^+ is (Xe) $4f^{14} 5d^{10}$

At this stage he furtherly informs to his students that the compounds of the above mentioned cations are all colourless and through discussion brings home the fact that d^{10} configuration does not impart any colour to the compounds usually.

Phase II Presentation of Learning Material.

Teacher now directs his students to carefully observe the Table 1.

Tabel 1

	Complex ion	Transitional Element	Unpaired Electrons and orbitals	Oxidation state of the transitional element	Colour
Group A	$\text{Fe}(\text{H}_2\text{O})_6^{3+}$	Fe	5	+3	Green
	$\text{Mn}(\text{H}_2\text{O})_6^{2+}$	Mn	5	+2	Pink
Group B	$\text{V}(\text{H}_2\text{O})_6^{2+}$	V	3	+2	Lavender
	$\text{Cr}(\text{H}_2\text{O})_6^{2+}$	Cr	3	+3	Violet

Teacher Students in group 'A' or in group 'B' the two elements falling in each of the group show difference in colour inspite of the fact that the number of unpaired electrons in each case is the same and the number of interacting ligands is the same. Would you let me know what for the difference in the colour still arises ?

Student Their size is different and consequently each transitional element interacts differently with the ligand field.

Teacher Right and summeries that one of the factors affecting the colour in the compound of d-block elements is size of the cation.

Teacher Let us now see the role of the nature of ligands in imparting colour to the elements in their compounds advises and students to have glance of Table 2 now.

Table 2

Complex Ion	Transitional Element	Unpaired Eelectron in d-orbitals	Oxidation stata of the element	Colour
$\text{Cu}(\text{H}_2\text{O})_4^+$	Cu	1	+2	Blue
$\text{Cu}(\text{NH}_3)_4^{2+}$	Cu	1	+2	Dark Blue
Cu Cl_4^{2-}	Cu	1	+2	Green
$\text{Cu}(\text{SCN})_4^{2-}$	Cu	1	+2	Black

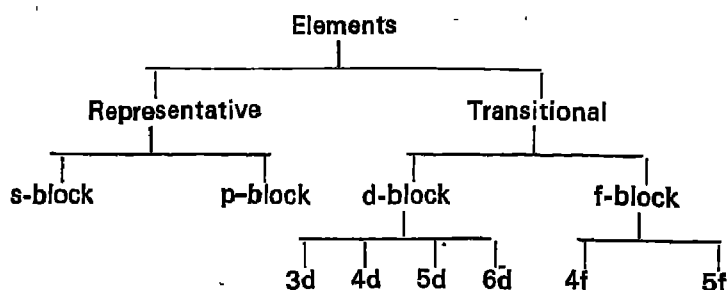
Teacher after this helps the students to conclude that the colour in the case of complex species is a function of the nature of ligands also. The teacher at this stage now introduces Table 3, which reveals dependency of the colour on the number of unpaired electrons present in d-orbitals.

Table 3

Complex Ion	Transitional Element	Unpaired electrons in d- orbitals	Oxidation stata of the element	Colour
$\text{Ti}(\text{H}_2\text{O})_6^{3+}$	Ti	1	+3	Voilt
$\text{V}(\text{H}_2\text{O})_6^{3+}$	V	2	+3	Green
$\text{Cr}(\text{H}_2\text{O})_6^{3+}$	Cr	3	+3	Dank Green Pinkish Violet
$\text{Mn}(\text{H}_2\text{O})_6^{3+}$	Mn	4	+3	
$\text{Fe}(\text{H}_2\text{O})_6^{3+}$	Fe	5	+3	Yellow

Phase 3 Strengthening Cognitive Organisation of Knowledge

Teacher—Look at the following figure :



Teacher d and f block elements are both termed as transitional elements. What is the difference between these ?

Student In case of d-block elements, chemistry of the elements is governed by electrons of ultimate and penultimate shell whereas that of f-block elements, the Chemistry is governed by electrons of ultimate, penultimate and anti-penultimate shells.

Teacher That is right. Why are the species MnO_4^- and CrO_4^{2-} also regarded as complex ions ?

Student Because O^{2-} in each case is regarded as ligand.

Teacher What are the names of these two species then ?

Student These are known as tetraoxo manganate (VII) and tetraoxo Chromate (VI) respectively.

Teacher Very good.

Promoting Active Reception Learning

Teacher—Oxalate ions too act as ligands. Can you infer from this fact as to why oxalic acid is utilised for removing the stains of rust and ink.

Student Iron in each case must be coming in the complexed form and helping to remove stains.

Teacher Yes this exactly is the reason of doing so.

Teacher Now are you at this stage in a position to judge the role of Roschelle salt in Fehling solution and that of citrate ions in Benedict's solution.

Student Both tartarate ions and citrate ions are used to complex Cu^{2+} ions in Fehling solution and Benedict's solution respectively.

Developing Critical Approach to Knowledge

Teacher Mg^{2+} , Ca^{2+} , Sn^{2+} , Pb^{2+} and several other cations also form complexes. Would you present a broader picture of the cations which can form complexes.

Student All such cations which possess high positive surface charge density and which have the availability of vacant orbitals to accommodate ligands, form complexes.

Teacher Nods his head in appreciation.

Teacher Oxidation state of Mn and Cr in MnO_4^- and CrO_4^{2-} ions is +7 and +6 respectively. In imparting these oxidation states each of the species attains d^0 configuration, yet MnO_4^- and CrO_4^{2-} are coloured. He further informs that substances like HgI_2 , Sb_2S_3 are also coloured and directs students to discuss amongst themselves and consult literature to have a more precise reason of colour exhibited by various species.

Students discuss amongst themselves, consult literature and come forward with the view that colour is attributed to the change of energy position of electrons in the formation of various species,

A Model Lesson Using Advance Organiser

Topic- HYDROXY COMPOUNDS

Contribution Made
by Participants

Phase I

(i) Aim

If you were allowed to choose aliphatic compounds more useful to the life, you would certainly pick up alcohols. From alcohols you could make nearly every other kind of aliphatic compound e.g. alkyl halide, alkenes, ethers, aldehydes, Ketones, acids, esters etc. From the alkyl halides you could make Grignard reagent and from the reaction between these and the aldehydes and ketones, you can obtain higher alcohols and so on. You could use alcohols not only as raw materials, but frequently as the solvents in which the reactions are carried out and from which products are recrystallised.

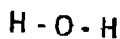
A detailed study of the chemistry of hydroxyl group (-OH) is very essential because of its presence in a number of biomolecules such as proteins, carbohydrates and nucleic acids. The presence of -OH group in these molecules render some of them water soluble so that the biochemical reactions involving these molecules may easily take place in homogeneous aqueous medium.

(ii) Defining the advance organiser

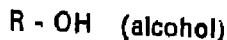
The alcohols are compounds of general formula ROH. Where R is any alkyl or substituted alkyl group. The compound may be open-chain or cyclic may contain a double bond a halogen atom an aromatic ring or additional hydroxyl groups. The properties of alcohols are influenced by the structure of the carbon atom to which -OH group is attached.

Teacher You are aware that alcohols can be considered to have been derived from the corresponding hydrocarbons by replacing one hydrogen atom by univalent -OH group.

Can alcohols as regarded be alkyl derivatives of water, where R may be any alkyl radical



water



(alkyl derivative of water)

Student Yes, alcohols are alkyl derivatives of water, where R may have a number of structural variations giving rise to different kinds of alcohols.

Teacher What are monohydric alcohols ?

Student Organic compounds containing one hydroxyl group are known as monohydric alcohols.

Teacher What is the parent member of the series called, which contains one or more hydroxyl groups attached to aromatic carbon atom ?

Student These compounds are called phenols.

(iii) Prompting awareness of learner's Knowledge.

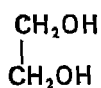
Teacher Observe the following compounds and classify them according to the number of hydroxy groups.



Ethyl alcohol

(Ethanol)

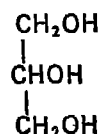
(a)



Ethylene glycol

(Ethane-1, 2-diol)

(b)



Glycerol

(Propane-1, 2, 3, triol)

(c)

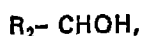
Student Compounds containing One—OH group are known as monohydric alcohols. However, the dihydric and trihydric alcohols contain two and three —OH groups respectively within a molecule.

Teacher Can the alcohols be classified according to the nature of carbon atom bearing the hydroxyl group ?

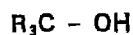
Student We know that a carbon atom is designated as primary (1°), Secondary (2°) or tertiary (3°) when one, two or three substituents are attached to carbon. The alcohols are designated as primary, secondary or tertiary depending upon the type of carbon atom to which the —OH group is attached.



(1° alcohol)



(2° alcohol)



(3° alcohol)

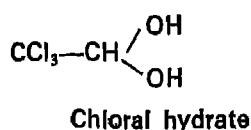
Teacher Do the three classes of alcohols always show similar properties ?

Student These three classes of alcohols have many similar chemical properties, owing to the presence of the same functional group —OH. Still there are differences due to the different number of hydrogen atoms on the hydroxyl — bearing carbon atom.

Teacher As the functional group of alcohols, the hydroxy group (—OH) determines the properties, characteristic of the family, variations in the structure of the R group bring about variations in these properties. Primary, Secondary and

tertiary alcohols, for example undergo a given reaction at different rates and sometimes by different mechanism. One reaction, oxidation, which directly involves the hydrogen atoms attached to the carbon bearing the -OH group, takes an entirely different course for each class of alcohols. Compounds in which the hydroxyl is attached directly to an aromatic ring are not alcohols, they are phenols, and differ so markedly from the alcohols, in chemical properties.

Teacher You know that chloral reacts with water with the evolution of heat and yields chloral hydrate $\text{-CCl}_3\text{CH(OH)}_2$ a stable crystalline compound. It can be represented as below.



Chloral hydrate is one of those universal and rare compounds which is stable in spite of the fact that there are two hydroxyl groups attached to the same carbon atom.

Phase II Presentation of learning material

Teacher directs the students to observe Table 1 carefully.

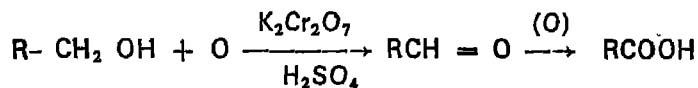
TABLE—1

Name	Formula	Structural formula	Class	B. P. (C)
Methanol	CH_3OH	$\text{H---CH}_2\text{OH}$	Primary	64
Ethanol	$\text{C}_2\text{H}_5\text{OH}$	$\text{CH}_3\text{CH}_2\text{---OH}$	Primary	78
Propan -1 -ol	$\text{C}_3\text{H}_7\text{OH}$	$\text{CH}_3\text{CH}_2\text{---CH}_2\text{OH}$	Primary	98
Propan-2-ol	$\text{C}_3\text{H}_7\text{OH}$	$\begin{array}{c} \text{CH}_3 \\ \searrow \\ \text{CH} - \text{OH} \\ \nearrow \\ \text{CH}_3 \end{array}$	Secondary	82
Butan -1 -ol	$\text{C}_4\text{H}_9\text{OH}$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{---OH}$	Primary	118
2-Methyl	$\text{C}_4\text{H}_9\text{OH}$	$\begin{array}{c} \text{CH}_3 \\ \searrow \\ \text{CH} - \text{CH}_2\text{OH} \\ \nearrow \\ \text{CH}_3 \end{array}$	Primary	108
Propan-1 -ol	$\text{C}_4\text{H}_9\text{OH}$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{---OH}$	Primary	100
Butan-2-ol	$\text{C}_4\text{H}_9\text{OH}$	$\begin{array}{c} \text{CH}_3\text{CH}_2 \\ \searrow \\ \text{CH} - \text{OH} \\ \nearrow \\ \text{CH}_3 \end{array}$	Secondary	100
2-Methyl	$\text{C}_4\text{H}_9\text{OH}$	$\begin{array}{c} \text{CH}_3 \\ \searrow \\ \text{C} - \text{OH} \\ \nearrow \\ \text{CH}_3 \\ \text{CH}_3 \end{array}$	Tertiary	83

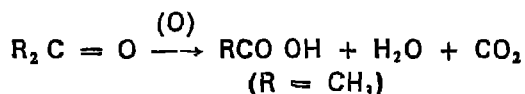
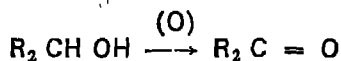
There are two isomers with formula C_3H_7OH , one, a primary and the other a secondary alcohol. There are four isomers of C_4H_9OH , two of which are primary alcohols, for 2-methyl propan -1 -ol is a primary alcohol as it possesses a $-CH_2OH$ group, even though it contains a branched alkyl chain. The third is secondary and the fourth is tertiary alcohol.

Teacher now explains the reactions of the $-OH$ group to distinguish between primary, secondary and tertiary alcohols.

1. A primary alcohol on oxidation, using acidic potassium dichromate or acidic permanganate solution gives an aldehyde first without change in number of carbon atoms and on further oxidation gives a carboxylic acid without change in the number of carbon atoms.

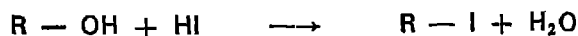
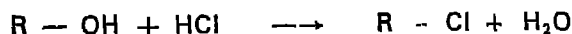


2. A secondary alcohol on oxidation gives first a ketone molecule without change in number of carbon atoms and on further oxidation give carboxylic acid containing one carbon atom less than those in the ketone.



3. Tertiary alcohols are usually resistant to oxidation as they contain no α -hydrogen (Concentrated sulphuric acid can however, dehydrates the tertiary alcohol to an alkene and other oxidant oxidise them).

Alcohols also react with the hydrogen halides to form alkyl halides.

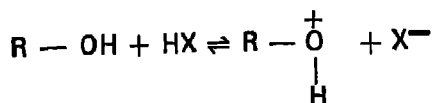


The reaction with hydrogen chloride is catalysed by zinc chloride. A test (Lucas test) is used to distinguish between primary secondary and tertiary alcohol. The tertiary alcohols react faster than secondary alcohols which in turn react faster than primary alcohols.

Test — The alcohol is shaken with a solution of zinc chloride in concentrated hydrochloric acid. Immediate cloudiness (due to formation of the alkyl halide) indicates tertiary alcohol, if the solution turns cloudy within about five minutes, a secondary alcohol is indicated, while primary alcohols show no cloudiness at room temperature.

Student What is the mechanism of this reaction ?

Teacher The mechanism of the reaction with a hydrogen halide depends on whether the alcohol is primary, secondary or tertiary. In each case the first step is the same, the alcohol reacts reversibly with the hydrogen halide.



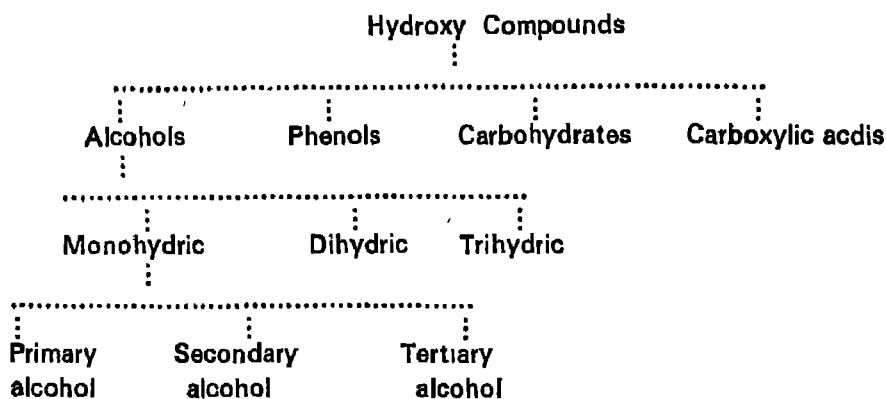
In the presence of strong acid, the oxygen atom of the alcohol acts as a base, accepting a proton from the hydrogen halide. Alcohols are very weak bases and the equilibrium lies to the left. Anhydrous zinc chloride is used to fasten the reaction. Consequent upon protonation water molecule is removed, carbonium ion is formed which interacts with X^- to form alkyl halide.

Phase III

Strengthening the Cognitive Organisation of Knowledge

Teacher: You have studied various hydroxy compounds.

The schematic link between various hydroxy compounds is as follows :



Promoting Active Reception Learning

Teacher Students you know that the presence of polarity in the molecules leads to strong attractive forces amongst the molecules, O—H bond being considerable polar, as a result alcohols have higher boiling points than compounds of similar molecule mass that lack polar groups. The following tables depict the effect of polarity on the boiling points of substances and dependence of solubility of alcohols on the nature of alcohols,

TABLE 2

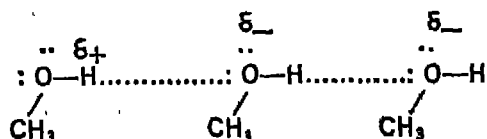
Effect of Alcohol Group on Boiling Points

Compounds and their Boiling points (C)		Difference between boiling point of Alcohol			
Hydrocarbon	Chloro-compound	Alcohol and Alkane and Chloroalkane			
Methane —162	Chloromethane —27	Methanol	65	227	92
Ethane — 89	Chloroethane 13	Ethanol	78	167	66
Propane — 42	1-Chloropropane 46	1-Propanol	98	140	52
	2-Chloropropane 37	2-propanol	83	125	46
Butane 0	1-Chlorobutane 78	1-Butanol	117	117	39
	2-Chlorobutane 68	2-Butanol	100	100	32
Pentane 36	1-Chloropentane 108	1-Pentanol	138	102	30
	2-Chloropentane 97	2-Pentanol	119	83	22
Heptane 98	1-Chloroheptane 159	1-Heptanol	175	77	16
Nonane 151	2-Chlorononane 190	2-Nonanol	194	43	4

Teacher What do you infer from this table ?

Student For a given series of the type alkane, halo-alkane and corresponding alcohol of the halo-alkane the difference between the boiling points of alcohol and alkane is always more than the corresponding difference between alkane and halo-alkane.

Teacher That is right and informs that in alcohols the intermolecular attractiveness goes beyond polar bond attractions. Because oxygen is electro negative and has unbounded electrons alcohols groups can form hydrogen bond with one another.



.....indicates hydrogen bonding in alcohols. This hydrogen bonding is stronger than the mere inter-molecular attraction of the type dipole-dipole interaction.

Teacher at this stage reminds students that solubility is another phenomenon that is a function of inter-molecular attraction prevailing in the system. He then presents Table 3 correlating the solubility of alcohol with nature of the alcohol.

TABLE 3
Water Solubility of Alcohols at 25°C

Compound	Structure	Solubility in water (g/100 g)
Methanol	CH_3OH	Miscible in all proportions
Ethanol	$\text{CH}_3\text{CH}_2\text{OH}$	...do...
1-Propanol	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	...do...
2-Propanol	$\begin{array}{c} \text{OH} \\ | \\ \text{CH}_3-\text{CH}-\text{CH}_3 \end{array}$	...do...
2-Methyl-2 propanol	$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3-\text{C}-\text{CH}_3 \\ | \\ \text{OH} \end{array}$	...do...
2-Butanol	$\begin{array}{c} \text{OH} \\ | \\ \text{CH}_3-\text{CH}_2-\text{CH}-\text{CH}_3 \end{array}$	12.5
2-Methyl-1 propanol	$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3-\text{C}-\text{CH}_2\text{OH} \\ | \\ \text{H} \end{array}$	11
1-Butanol	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$	8

Through discussion he impresses upon students the point that solubility considerations involve the balance of polar and non-polar groups within a molecule, as well as molecular shape. The more polar a molecule and the more compact its shape, the greater will be its water solubility.

3. Developing Critical Approach to Knowledge

Teacher Students in molecules with more than one alcohol group, these effects are greater. He informs students that in carbohydrates, all but one of the carbon atoms have alcohol groups.

Teacher How do you feel effects such as boiling point and solubility of carbohydrates in water should be more ?

Student Carbohydrates can be hydrogen bonded to water and to each other very strongly.

Teacher Yes ! He at this stage further informs that many carbohydrates have such high melting points that they decompose (lose their chemical structure because covalent bonds break) rather than melt on heating. He introduces this process as Caramelizing, used in candy making, where a small amount of the decomposition product imparts a desirable flavour.

Appendix — I

**List of participants who attended the programme from 16-8-88 to 21-8-88,
Venue of Programme R.C.E., Bhopal.**

- | | |
|--|--|
| 1. Mr. Fernando O'DE. S.R. Sequeira
Lobe, Bhempe college H.S.S. Panjim,
Goa | 11. Mr. Bisahu Ram Agrawal,
Govt. Hr. Sec. School
Hatbandh Raipur M.P. |
| 2. Shri N.R. Patki,
Shri Shanta Durgn Hr. Sec. School,
Bicholim—Goa | 12. Proi. Vithal G. Kendre,
J.E.S. College, Jalna,
Distt. Jalna M.S. |
| 3. Miss Seema J. Kamat,
Fr. Angel Junior Colloge, Pilar, Goa | 13. Mr. Kunjrvihari M. Bhavear,
Rajpipla, Govt. Hr. School,
Rajpipla Gujarat. |
| 4. Mr. Joshi Rajabhau Nathroa,
Vidya Mandir Jr. College,
At and Post Vairag Tal. Barsi, Solapur | 14. Mr. Nazhar Mohd. Munshi,
Govt. Bai Vinay Manny Mandir,
Hr. Sec. School Indore |
| 5. Mr. Tarte, Nandkumar Ramchandra,
The Model Multipurpose Jr. College,
Malinagar Distt. Solapur | 15. Sh. S.P. Shrivastava,
Govt. H. S. School Daulatganj
Ujjain |
| 6. Mr. Sadanad G. Phadte,
G.V.M's Higher Secondary School,
PONDA, Goa | 16. Sh. A.A. Modi, Lect.
SIE Pr. Training College Compound
Raikhad, Ahmedabad. |
| 7. Mr. Alcantro Lobo,
M.E.S. Jr. College of Science,
and Voc. Education,
Vasco, Goa. | 17. Sh. L.V. Pawar, Lect.
Petil Jr. College Sangammer
Dist. Ahmad Nagar M. S. |
| 8. Mr. J.J Bhadani,
Shri D.M.V.M. Bhavnagar.
Dist. Gujarat. | 18. Prof. P.P. Patil, Lect.
N.N. Patil Jr. College Poynad
Dist. Raigad M.S. |
| 9. Mr. U.H. Bhatt
Majira Oiris High School,
Bhavnagar, Gejarat. | 19. Mr. P.U. Patil, Lect.
N. M. Joshi Jr. College Goregaon,
Tal. Mangaon Distt. Raigad |
| 10. Mr. Patel Vasant A.
Sheth Khimji Ramdas Kanya Vidyalazya,
Mandir, Kutch, Gujarat. | 20. Prof. Bijalpure L.M.
Pemraj Sarde Lodge, Ahmednagar,
M. S. |

21. Mr. Nirgide R.N.
M. Gandhi Jr. College Nira,
Tah. Purandar, Distt. Pune
22. Mr. Nirgide R.N.
M. Gandhi Jr. College Nira,
Tah. Purandar, Distt. Pune
23. Mr. K.K. Khare,
Govt. Boys Hr. Sec. School,
Patharia, Distt. Damoh
24. Mr. P.V. Sabara,
N.T.M. High School,
Surendra Nagar Gujarat
25. Mr. R.K. Bhanushai
Sajuba Girls High School,
Jamnagar, Guj
26. Mr. NS. Prajapati,
Shri R.P. High School, Harij
North Guj
27. Mrs. Rosaline Correa,
S.M. Choksey High School,
1985, Convent Street, Pune
28. Mr. V.K. Gupta,
Govt. Model Hr. Sec. School,
Barela (Jabalpur).

PART II

CONCEPT ATTAINMENT MODEL

Concept Attainment Model

S. N. Tripathi

Definition of a Concept

Concepts are cognitive organizing systems which serve to bring pertinent features of past experience to bear upon a present stimulus object. Vinacke (1954, 1.1).

A concept is a class of stimuli which have common characteristics. These stimuli may be objects, events, or persons. De Cecco (1970, p. 385).

It is in order to cope with the environment that we engage in the process of categorizing, which means that we render discriminately different things equivalent respond to them in terms of their class membership rather than their uniqueness. Bruner (1936).

Forming concepts benefits us in three ways :

- (1) reduces the complexity of the environment.
- (2) gives us the means by which we identify objects in the world.
- (3) reduces the necessity of constant learning.

Examples of concepts

Book From encyclopaedia to a small book all are treated as equivalent.

Country From U.S.S.R. to Mauritius.

Name of a particular object is not a concept. Raj Nath Pande is not a concept but Pande could be a concept. Pande is the surname of a community among Brahmins.

Concept Formation and Concept Attainment

When a large amount of data is given the individual tries to form categories. This will lead to concept formation. In concept attainment the concept has been formed in advance. The task is to find out what the concept is.

Concepts should be distinguished from facts, generalizations or rules, and theory. There can be a generalization which defines a concept. There can be generalizations which make use of concepts. A theory is a set of facts and rules.

TYPES OF CONCEPTS

Conjunctive Appropriate values of several attributes are jointly present, Take for example mango. Its attributes are :

- (a) Shape; elongate (b) Colour; green, yellow, red
(c) Taste : sweet to sour (d) Food.

2. **Disjunctive** The appropriate value of one attribute or of another attribute or both are present. Examples;

Citizen : by birth, by marriage, through parents.

Supplementary Examination, Fails in one theory paper and/or one practical.

Driving Offence : driving in the night without light and/or without license.

3. **Relational**, Mother, tall, fair, south, heavy.

Concepts can also be classified in terms of whether their attributes are observable or not.

Attributes and Values

A concept can be understood in terms of its attributes. Attributes are like properties. Take the concept of 'square'. 'Square' has three attributes. These are : (1) All the four sides are equal, (2) all the four corners form right angles, and (3) all the sides are formed by straight lines.

Values are variations that an attribute may undergo. Blue colour may range from light blue to deep blue. Different shades of blue will be the values of this attribute. Similarly, the attribute acute angle has a large number of values ranging from angles that fall between zero degree and ninety degree.

A value can be changed into an attribute if it is specified as the characteristic of a concept.

Critical Attributes and Noisy Attributes

The distinguishing attributes and their value range are called critical attributes of a 'square' have been described above. Noisy attributes are nonessential characteristics. In the case of 'square' noisy attributes are size, position, and colour. A square can be large or small. It can be in the shape of a diamond. It can have any colour. Students have to learn that they have to ignore noisy attributes.

The number of attributes may differ from concept to concept. The difficult concepts have a large number of attributes. They also have attributes which are not easily recognizable.

1. **Observed Concepts** Attributes are concrete and manipulable.
2. **Inferred** attributes can be inferred; anger, pleasure,
3. **Ideal-type** symbolic material; democracy,

Concept Attainment Models

Bruner has given three models of concept attainment.

1. **Reception Model**

2. Selection Model

3. Unorganized Material.

In our day-to-day life we have to deal with unorganized material and draw concepts from it. An example of this has been given above. Let us take the other two models.

1. Reception Model	Characteristics	of Yeses	Possible Hypotheses
Milk Yes	Liquid, emulsion food	four letters 'm', 'i', 'l', 'k' any are all of these letters	
Silk No	Not liquid Not food Not i, l, k,		Could be liquid food four letters, letter M
Mill No	Not 'M'		any four letter word
Juice Yes	Liquid food five letters		could be five letters
Bread No	Not solid food		could be liquid food
Tea Yes	Could be of three letters		liquid food

What type of concept is it ? Conjunctive.

Selection Model

In the selection model the examples are not marked as 'Yes' or 'No.' The student selects an example and asks whether it is a 'Yes' example or a 'No' example.

Strategies

In the Reception Model there are two main strategies. These are : (1) Wholist and (2) Partist.

1. Wholist, Here the individual takes the first positive instance and uses it in toto as a guide comparing all the attributes of the first instance with subsequent instances.

Partist. In the partist strategy the choice of a hypothesis is based on only part of the initial example. If the initial hypothesis is not confirmed, the partist refers to all the previous instances and changes the hypothesis.

In selection model four strategies can be used.

1. Simultaneous Scanning. After each choice the individual deduces which have been eliminated. He carries any hypotheses in his memory. In the next choice he tries to eliminate as many as possible.

2. Successive Scanning Only one hypothesis is taken at a time,

3. Conservative Focusing. The individual makes a plus attribute as a focus and alters one attribute at a time.

4. Focus Gambling The individual tries to change more than one attribute.

(1) Reception-Oriented Concept Attainment Model

Phase One	Presentation of Data and Identification of Concept	Phase Two Testing attainment of the concept	Phase Three Analysis of Thinking Strategies
Present labeled examples		Identify additional unlabeled examples as 'Yes' or 'no'.	Describe thoughts
Compare attributes in positive and negative examples			Discuss role of hypothesis and attribute
Generate and test hypotheses.			Distinguish amongst number of hypotheses
Name the concept.		Generate examples	
State a definition according to essential attributes			Evaluate the strategies.

(2) Selection-Oriented Concept Attainment Model**Phase One : Presentation of Data and Identification of Concept**

Present Unlabeled examples

students enquire which examples, including their own, are positive ones.

Rest same as Reception Model.

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Theory Checkup for the Concept Attainment Model

Instructions—Circle the response that best answers the questions or completes the statement. Check your answers with the key that follows the exercise.

1. The process of Concept Attainment is best described as
 - (a) putting data in new categories
 - (b) learning a new concept
 - (c) distinguishing the relevant attributes for placing data into defined classes
 - (d) naming a new concept.
2. Concepts have six elements. Which of the following is not an element of concepts ?
 - (a) name
 - (b) positive exemplar
 - (c) critical attribute
 - (d) theory.
3. Which of the following is an essential attribute of the concept of 'flower' ?
 - (a) yellow
 - (b) tall
 - (c) colour
 - (d) decorative.
4. As young children learn to speak, they acquire in vocabulary very quickly, putting names with objects and events. Would you see the concept attainment model with a two year old to teach these symbols.
 - (a) Yes
 - (b) No.
5. What is the relationship between a rule and an attribute ?
 - (a) Rules give examples of the concept.
 - (b) Rules are definitions that specify the essential and non-essential attribute of the concept.
 - (c) Rules specify the name of the concept.
 - (d) Rules state the essential attributes of the concept.
6. Shape is an essential attribute of a basketball. Is it an essential attribute of the concept of transportation ?
 - (a) Yes
 - (b) No
7. Size is an essential attribute of the concept of adult. Five feet, six inches is a (n).....of the attribute 'size'
 - (a) positive exemplar
 - (b) negative exemplar
 - (c) value
 - (d) critical attribute

8. If you walked into a class-room and saw the teacher presenting objects and asking students to say whether they were 'yes' or 'no', you would be observing what phase of the Concept Attainment Model ?
- (a) Phase two : testing concept attainment.
 - (b) Phase one : presentation of data and identification of concept
 - (c) Phase four : analysis of concepts in unorganized data
 - (d) Phase three : an analysis of thinking (Concept Attainment strategies)
9. 'Small' is what kind of Concept ?
- (a) conjunctive
 - (b) disjunctive
 - (c) not a concept at all
 - (d) relational.
10. Ms. Smith wanted to teach students the concept 'public policy issue', so she developed a curriculum in which the students studied four current public policy issues during a period of six weeks criticize. Ms. Smith's curriculum plans from the point of view of Bruner's theory of concepts.
- (a) Sixth graders are too young to understand conjunctive concepts.
 - (b) Ms. Smith did not identify the essential attributes.
 - (c) There are no negative exemplars
 - (d) Ms. Smith did not state the rule ahead of time.
11. What is the major difference between conjunctive and disjunctive concepts ?
- (a) Disjunctive concepts have a relationship to other concepts.
 - (b) Disjunctive concepts don't have all the attributes.
 - (c) Disjunctive concepts are not as powerful as conjunctive ones.
 - (d) Disjunctive concepts require the presence of some attributes and the absence of others.
12. Bob Jones was teaching a Concept Attainment lesson to his students. The concept was 'capitalism' Bob showed his students several pictures. Some were of government buildings in the Soviet Union, others were of India and Cuba, and the rest which consisted of scenes such as a steel mill and the Stock Exchange, were of the United States. The students could not grasp the attributes of the concept. What was the problem ?
- (a) The students did not understand English very well, their native language was Spanish.
 - (b) Bob did not have enough exemplars
 - (c) The positive exemplars did not contain all the attributes of concept.
 - (d) The students did not have an experimental base for concept.

13. The following statement, 'Intelligence is a product of heredity and environment', is a
- (a) concept (b) fact
(c) skill (d) generalization.
14. 'Japanese students scored higher on math than other national groups, whereas Swedish students did better in English composition'. This statement is a
- (a) theory (b) generalization
(c) concept (d) datum
15. If you want to present the rule first, you would use which concept learning model?
- (a) Taba's Inductive Thinking Model
(b) Ausubel's Advance Organizer Model
(c) Suchman's Inquiry Training Model
(d) Bruner's Concept Attainment Model
16. Which characteristic is not related to the difficulty of a concept?
- (a) scope
(b) number of generalizations in which the concept is used
(c) type of concept (d) concreteness

CONCEPT ATTAINMENT MODEL

Exercise 4 : Conceptual Versus Symbolic Activity

To illustrate the difference between learning symbols and learning concepts, see if you can identify the essential attributes of the following concepts, which should be familiar to you. This will indicate whether you learned these terms as vocabulary (or symbols), or as concepts.

Concept

Essential Attributes

Family

Food

Transportation

Religion

Exercise 5 : Attributes and Attribute Values

Concept	Essential	Non-essential	Value Range for Essential Attributes
Apple	1. 2. 3.		
Television			

Exercise 6 : Exemplar

For each of the following concepts, describe at least two positive and two negative exemplars. Identify at least one missing essential attribute in each of your negative exemplars

Concept	Positive Exemplar	Negative Exemplar
hat	1. 2.	1. 2.
Poverty	1. 2.	1. 2.

Questions—Is a newspaper a positive or negative example of 'hat' ?

Is a scarf a positive or negative example of 'hat' ?







Is the woman walking down the street during a rain-storm with a newspaper held over her head a positive or negative example of 'hat' ?

Exercise 7 : Elements of a Concept

1. name
2. essential attributes

3. non-essential attributes
4. positive examples (exemplars)
5. negative examples (exemplars)
6. rule.

Instructions : For each concept in the following table, supply the missing elements (s).

Concept Name	Positive exemplar	Negative exemplar	Essential attribute	Non-essential attribute
1.				
2. Automobile			mobility engine function : transportation	colour-size shape
3. Brother				
4	 	 	One or more support flat surface func- tions : work area	size shape drawers

Now write a rule for each concept.

- 1.
- 2.
- 3.
- 4.

Exercise 8 : Types of Concepts

List four concepts that you teach during the school year. Check whether the concept is conjunctive, disjunctive, or relational, and whether it is an ideal-type concept.

1.Conjunctive—Disjunctive—Relational—Ideal-Type
2.Conjunctive—Disjunctive—Relational—Ideal-Type
3.Conjunctive—Disjunctive—Relational—Ideal-Type
4.Conjunctive—Disjunctive—Relational—Ideal-Type

PLANNING & PEER TEACHING :

1. Select a concept
 - (a) Locate a concept
 - (b) Determine if it is a concept
 - (c) Decide if it is worth teaching
 - (d) Decide if it is appropriate for the learner(s)
2. Analyze the concept :
 - (a) Determine its essential and nonessential attributes.
 - (b) Is it conjunctive, disjunctive, or relational ?
 - (c) Is it observed, inferred, or ideal-type ?
3. Determine objectives :
 - (a) Identify specific goal or goals.
 - (b) Generate behavioural objective for the goals.
4. Prepare exemplars :
 - (a) Determine the most appropriate medium for exemplars.
 - (b) Generate exemplars.
 - (c) Check exemplars for 'noise'.
 - (d) Check exemplars for variety.
 - (e) Sequence the presentation of exemplars.
 - (f) Organize the presentation of exemplars.
5. Planning Guide for Concept Attainment Models :
 1. Analysis of concept
 2. Essential attributes of concept.

a.	b.	c.	d.
----	----	----	----
 3. Non-essential attributes of concept.

a.	b.	c.	d.
----	----	----	----
 4. State the Rule :
- II. Type of Concept :
 5. Circle One: Conjunctive, Disjunctive, relational.
 6. If the concept is conjunctive or relational, do all the 'yeses' contain all the essential attributes Yes..... No.....or, if the concept is disjunctive, do all the 'yeses' contain at least one essential attributes ? Yes..... No.....

III. Objectives :

7. Write three behavioural objectives that students will accomplish in this lesson.

a.

b.

c.

IV. Exemplars :

8. Describe the 'Yes' exemplars

9. Describe the 'No' exemplars.

10. Is the medium of presentation (pictures, words, paragraphs) suitable for the concept ?

11. Do you have a sufficient number of 'Yes' and 'no' exemplars ?

**12. How many of the 'no' exemplars have none of the essential attributes ?
.....How many of the 'no' attributes ?**

V. Phases of the Model :

13. Write your opening move for each phase of the model.

Phase One : Presentation of Data and Identification of the concept.

Phase Two : Testing of the concept Attainment.

14. For each essential attribute in your concept, write two questions that will elicit from students those characteristics in the exemplar. Which make it essential attribute.

**a. Attribute
question(s)**

**b. Attribute
question(s)**

**c. Attribute
question(s)**

**d. Attribute
question(s)**

TEACHING ANALYSIS GUIDE FOR THE RECEPTION MODEL OF CONCEPT ATTAINMENT

This Guide is designed to help you analyze the process of teaching as you practice the Reception Model of Concept Attainment. The analysis focuses on aspects of teaching that are important to the syntax of the model, the teacher's role, and specific teaching skills.

The Guide consists of a series of questions and phrases. As you observe a practice session (whether peer teaching or microteaching), analyze the teaching using the rating scale that appears opposite to each question and statement. This scale uses the following items :

Thoroughly (TH) This item signifies that the teacher engaged in the behaviour to the point where students were responding comfortably and fluently. Appropriateness varies from situation to situation. For example, young children may need more assistance in describing the exemplars than older ones.

Partially (P) : This item signifies that the teacher engaged in appropriate behaviour, but not as thoroughly as possible. There is some doubt about whether the student are responding fully.

Missing (M) : The teacher did not engage in the behaviour there appears to be loss, in student response.

Not Needed (NN) : The teacher did not explicitly manifest the behaviour, but there is no loss. Then the behaviour was included in others or the students began appropriately without being led to.

For each question or statement in the Guide, circle the term that best describes to respond to the teacher's behaviour.

PHASE ONE : Presentation of Data and Identification of the Concept.

1. Did the teacher state the purpose of the game ?

TH P M NN

2. Did the teacher explain the procedures of the game.
(how the 'yeses' and 'nos' function) ?

TH P M NN

3. Did the initial 'yes' clearly contain the essential attributes ?

TH P M NN

4. If teaching a conjunctive concept, did the teacher begin with a 'yes' exemplar ?

TH P M NN

or

If teaching a disjunctive concept, did the teacher begin with a 'no' exemplar followed by a 'yes' ?

TH P M NN

5. Did the teacher ask questions that focused students' thinking on the essential attributes ?

TH P M NN

6. Did the teacher ask the students to compare the 'Yes' exemplars ?

TH P M NN

7. Did the teacher ask the student to contrast the attributes of the 'Yes' exemplars with those of the 'no' exemplars ?

TH P M NN

8. Did the teacher present labeled exemplars ?

TH P M NN

9. Did the teacher ask the students to generate and test hypotheses about the identity of the concept ?

TH P M NN

10. Did the teacher ask students to name the concept ?

TH P M NN

11. Did the teacher ask the students to state the essential attributes of the concept ?

TH P M NN

PHASE TWO : Testing Attainment of the Concept.

12. After the concept was agreed upon, did the teacher present additional exemplars and ask whether they contained the concept ?

TH P M NN

13. Did the teacher ask the students to justify their answers ?

TH P M NN

14. Were the students able to supply their own exemplars to fit the concept ?

TH P M NN

15. Did the teacher ask the students to justify their exemplars by identifying the essential attributes ?

TH P M NN

PHASE THREE : Analysis of Thinking Strategies.

16. Did the teacher ask the students to describe the thinking processes they used in attaining the concept ?

TH P M NN

17. Did the teacher ask the students to reflect on the roles of attributes and concepts in their thinking strategies ?

TH P M NN

18. Did the teacher ask the students to evaluate the effectiveness of their strategies ?

TH P M NN

Model Lesson in Chemistry

On Concept Attainment Model

Type : Reception Oriented Model

Dr. I. P. Aggarwal
RCE, Bhopal

Class XII

Concept : IONOPHORES

Type : Conjunctive

Essential Attributes

1. Ionic solids.
2. Conductor of electricity in molten state.

Non essential Attributes

1. White coloured substances
2. Hygroscopic substances
3. Strong electrolytes
4. Aqueous solution of substances being neutral.
5. Particular class of the compounds (Say Metal Chlorides)

General Behavioural Goals

1. define ionophores
2. differentiate between ionophores and ionogens.
3. give examples of ionophoric substances.
4. suggest a criteria to label the compound as ionophoreic electrolyte.

Phase one Presentation of Data and Identification of Concept

Teacher You are aware that ions play a dominant role in our daily life. Our body makes use of several ions, important amongst them being Na^+ , K^+ , Ca^{2+} , Fe^{2+} . These ions we achieve through their compounds. Today, I am going to teach you some concept pertaining to the compounds that furnish ions. I am not going to tell you the characteristics of the types of compounds that I have in my mind. I would only be giving you the positive and negative exemplars of my teaching print, you would locate through the characteristics of positive and negative examples, what it is that I wish to teach you. The first positive example of my teaching point is :—

Teacher NaCl (s) positive example

You may now suggest the various characteristics of this compound that arise in your mind.

Student 1 Crystalline solids

Student 2 Ionic compounds

Student 3 White coloured substances

Student 1 Hygroscopic substances

Student 4 Substances which are conductor of electricity in the molten state.

Teacher How did you infer this ? (Pointing out to student 4)

Student 4 Based upon the fact that in Down's process for the extraction of sodium, we affect the electrolysis of molten sodium chloride.

Teacher Well, you seem to have picked up a good point.

Teacher Are there some more characteristics that come to your mind ?

Student 5 It may be strong electrolyte.

Teacher Yes, may be we list it out also.

Student 6 Substances whose aqueous solutions are neutral towards litmus solution.

Student 7 Perhaps you wish to talk about chlorides of metals.

Teacher lists out all the attributes advanced by the students and takes care of the point that in describing these attributes (characteristics) he ensures the participation of maximum number of students.

Teacher That's nice, we have sufficient material now to proceed ahead. Next focus your attention on the negative example.

Teacher $\text{NH}_2\text{CONH}_2(\text{s})$ Negative example

Teacher Well, now you may prepare a list of the characteristics of urea which are common to sodium chloride solid and then formulate your opinion as to what characteristics are not possible about the idea I wish to teach.

Teacher 3 White coloured substances whose aqueous solutions are neutral do not seem to be the essential characteristics of the substances about which you wish to talk.

Teacher O. K., we may now categorize it as non-essential characteristics.

Teacher Now once again see two positive examples of my teaching idea and examine if some of the characteristics you have stated earlier could also be labelled as nonessential.

Teacher KCl(s) Positive example
 $\text{AlF}_3(\text{s})$ Positive example

Student 3 Hygroscopic substances and chlorides of alkali metals do not seem to fit into our discussion.

Teacher That's good and marks these also as the non-essential attributes.

Teacher Very often you make use of the following mineral acids in the laboratory, what I wish to emphasise here is these are not the examples of my teaching point.

Teacher HCl (l) Negative example
 $\text{HNO}_3 (\text{l})$ Negative example
 $\text{H}_2\text{SO}_4 (\text{l})$ Negative example

Teacher You may once again compare the characteristics of positive and negative examples to highlight what this teaching point is after all.

Student 4 Only compounds furnishing ions (ionizable compounds) also is not the essential characteristic of your teaching point.

Teacher Fine. Now, to help you arrive quickly on the essential characteristics of my teaching point, I am citing two more nonexamples of my teaching point.

Teacher $\text{HgCl}_2(\text{s})$ Negative example
 $\text{AlCl}_3(\text{s})$ Negative example

Student 2 I got it, you wish to talk about only such class of ions producing substances which are solids and whose melts even are conductors of electricity.

Teacher May be you are right.

Phase Two Teacher at this stage presents the following unlabelled examples and students categorize them as yes or no examples.

Yes Examples	No Examples
LiCl (s)	H_2S
CsCl (s)	H_3PO_4
NaBr (s)	H_3PO_3
KBr (s)	$\text{SnCl}_2 (\text{s})$
NaC (s)	$\text{FeCl}_3 (\text{s})$
KI (s)	$\text{MnCl}_2 (\text{s})$

Teacher Good, I am confident that you have picked up my idea. I wished to talk about ionic solids whose melts are conductors of electricity and these are named as **IONOPHORES**.

Teacher at this stage asks students to present further examples and point out essential attributes in the examples.

Questions to arouse critical awareness of students about essential attributes.

1. What is the arrangement of sodium and chloride ions in solid sodium chloride? Is this arrangement applicable to Cesium Chloride also?
2. Could formation of ionic solid from its elements be labelled as redox change?
3. Theoretically it may be possible to extract aluminium from melt of aluminium fluoride but same is not possible with melt of aluminium chloride. Why?
4. How is the melt state of any substance different from its aqueous solution?
5. Suggest an experiment to label Cesium Chloride as ionic solid.
6. Classify the following into ionophores and ionogens KF(s) , $\text{BiF}_3\text{(s)}$, $\text{SnF}_4\text{(s)}$, $\text{FCH}_2\text{COOH(l)}$, $\text{MgF}_2\text{(s)}$ and HF(l) (Hint : Ionogens are those compounds which produce ions in appropriate situation and are not composed of ions).

Model Lesson in Chemistry

On Concept Attainment Model

Type ; Selection Oriented Model

Dr. I. P. Aggarwal

R. C. E., Bhopal

Class XI

Concept—Basicity of Oxoacids

Type of Concept—Relational

Essential Attributes

1. Hydrogen present in the molecule and linked through oxygen in the molecule.
2. Hydrogen present in the molecule and not linked through oxygen.

Nonessential Attributes

1. Non-oxoacids
2. Oxo-acids containing carboxylic group with isostructural hydrogen atoms.
3. Oxo-acids not containing carboxylic group with isostructural hydrogen atoms.
4. Weak and strong nature of the acids.
5. Acids having same basicity.

Critical Attribute

Number of HO-groups present in the molecule of oxoacids.

General Behavioural Goals

After the completion of the lesson students should be able to :—

1. define basicity of the acids
2. differentiate between acidic and non-acidic hydrogen present in the molecule
3. ascertain equivalent mass of the acids from the given molecular mass of the acids.
4. suggest structures of given acidic substances having known their basicity.

Phase 1 Presentation of Data and Identification of Concept

Teacher You all know that acid-base systems are of great importance to us. Vitamin C itself is labelled as ascorbic acid. A slight acidity in our stomach causes us

great uneasiness. Today I wish to teach to you something regarding the acidic substances. What exactly is my teaching point, explicitly I am not going to tell you, I shall only be presenting random examples of my idea, you may pick up any one out of these examples and I will help you mark this either positive or negative example of my teaching idea.
Teacher then presents the following randomly arranged examples.

Examples and non examples of teaching point

- | | | | |
|-----------------------------------|------------------------------------|--|-----------------------------------|
| 1. HCl | 2. HNO ₃ | 3. HCOOH | 4. H ₃ PO ₄ |
| 5. HBr | 6. HI | 7. H ₃ PO ₃ | 8. CH ₃ COOH |
| 9. H ₃ PO ₂ | 10. H ₂ SO ₄ | 11. $\begin{array}{c} \text{COOH} \\ \\ \text{COOH} \end{array}$ | |

At this stage, one of the students (marked student 1) asks what about H₃PO₃, related to the teaching point.

Teacher H₃PO₃ is a positive example

Teacher after stating this as the positive example asks the students to think about various attributes that arise in their mind about this positive example. Students discuss among themselves and present following attributes.

1. Acids containing oxygen as their essential constituent known as oxoacids.
2. Acids whose ionizing tendency is less, called as weak acids.
3. Basicity of acids.
4. Oxoacid of phosphorus where oxidation number of phosphorous is three.
5. Acids exhibiting more than one dissociation constant values.

Teacher Good going. Let us now bring in our discussion, one more example,

Student 1 What about HI ?

Teacher HI is non exemplar of my teaching point.

Student 2 It seems that non-oxoacids which are strong ones is not your idea.

Teacher (Pointing out towards student 2) may be you are on the right track.

Student 3 I would like to inquire about H₂SO₄ molecule.

Teacher H₂SO₄ also is not the example of my teaching point.

Student 4 I have started getting it, I feel H₃PO₄ should be positive exemplar of your idea

Teacher Yes It indeed is positive example of my idea.

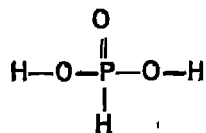
Student 5 How about HCOOH ?

Teacher This acid too is not the example of my teaching point.

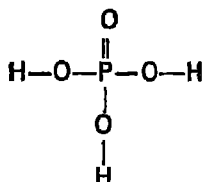
Student 6 It seems to me that weak acids as well as acids exhibiting more than one dissociation constant values are not the focal point of our discussion.

Teacher Fine. Surely these two are not the focal points of our discussion.

Teacher May I at this stage suggest you to write the structural formulae of the acids which we have marked as the positive exemplars. Teacher helps students to arrive at the following structural formula



(H_3PO_3)

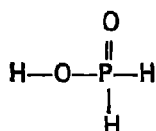


(H_3PO_4)

Student 6 I got your idea but before I express it, I would like your decision sir, about H_3PO_2 .

Teacher H_3PO_2 too is the positive exemplar of my teaching point.

Student 6 This too has 3 hydrogen atoms in it but structurally it is



Student 6 further opines that the basicity of H_3PO_2 , H_3PO_3 and H_3PO_4 is respectively 1, 2, 3. He further goes on to express that the focal point of discussion is : Basicity of acids as related to the number of HO— groups present in the molecule.

Teacher Nods his head in agreement.

Phase 2 Teacher at this stage asks student to tell the basicity of the following acids, which is categorized so by the students as indicated here—

CH_3COOH}	.....	Monobasic
$\begin{array}{c} \text{COOH} \\ | \\ \text{COOH} \end{array}$	.....	Dibasic
$\begin{array}{c} \text{CH}_2\text{COOH} \\ | \\ \text{CH}_2\text{COOH} \end{array}$	.....	Dibasic
H_2AsO_4	.....	Tribasic

Teacher I am confident that you followed my idea and rewords it as :

“In oxoacids the basicity of acids is determined by the number of HO— groups present in the molecule.”

Phase 3 Analysing thinking strategies of students

Teacher Asks student 1, what prompted him to think about HI.

Student 1 Since HI does not contain oxygen, I thought if I asks about this example then two things, the halogen acids and strong acids would not further figure in our discussion. Teacher agrees with his view point.

Teacher Then asks student 3, what made him to inquire his view point.

Student 3 I wanted to narrow down the discussion by eliminating the behaviour of strong oxoacids from the discussion. Teacher at this stage inquires about the behaviour of student 4 and 5.

Student 4 I simply gambled that the point of discussion could be different types of acid formulated by phosphorus.

Student 5 I still thought that weak oxoacids could be the point of discussion.

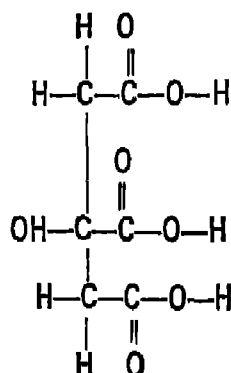
(Teacher at this stage does not feel the necessity of further probing the strategy of thinking on the part of student because all various hypotheses were already eliminated)

Question to arouse critical awareness of students about essential attributes

1. Point out the basicity of the following phosphorous acids



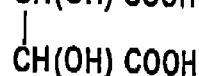
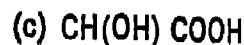
2. Structure of citric acid is



its basicity is 3 and not 4. Why ?

3. Phenol is acidic in nature while alcohol is not why ? How many acidic and non-acidic hydrogen atoms are present in the molecule of phenol ?

4. What will be the equivalent mass of the following acids ?



Model Lesson in Chemistry

On Concept Attainment Model

Type—Reception oriented model

Dr. P. N. Pathak

R.C.E., Bhopal

Class—XII

Concept—Enthalpy of formation

Type—Conjunctive

Essential Attributes

1. Enthalpy change is the change in heat content of a system at constant pressure.
2. Enthalpy of formation may be positive or negative.
3. Only one mole of a compound is formed from the elements.
4. Reactants and products should be in their standard state.

Nonessential Attributes

1. Exothermic change
2. Spontaneous reaction
3. Redox reaction
4. Change of state obtained in the formation of products
5. Enthalpy of a reaction
6. Endothermic change.

Previous Knowledge required

Students are familiar with

1. Exothermic reactions
2. Endothermic reactions
3. Enthalpy of oxidation
4. Enthalpy of combustion
5. Enthalpy of reaction.

General Behavioural Goals

Students will be able to

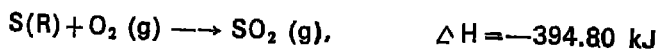
1. define enthalpy of formation
2. differentiate between enthalpy of formation and other enthalpy changes

3. give examples of enthalpy of formation
4. appreciate the importance of writing the state of substances in reactions involving thermal changes,

Phase 1 Presentation of data and identification of the concept

Teacher You are familiar with nitrogen cycle in which nitrogen reacts with oxygen in cloudy weather due to thunder produced by friction of clouds forming nitric oxide (NO). NO further reacts with oxygen forming NO_2 . In burning of fuels and in preparation of ice cream enthalpy changes takes place.

Today I am going to teach your concept of thermochemistry. I am giving you only positive and negative examples of my teaching points. From these examples you would locate the concept in my mind. The first example of my teaching point is



Please suggest the various characteristics of this equation that occur to you.

Student 1 Change in enthalpy in this reaction is -394.80 kJ

Student 2 Enthalpy of reaction is negative i.e. the reaction is exothermic.

Student 3 It is a spontaneous reaction.

Student 4 It is a redox reaction.

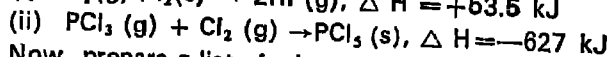
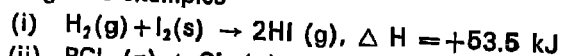
Student 5 Combustion of sulphur has taken place.

Student 6 Change of state of sulphur is taking place in the formation of sulphur dioxide.

Teacher lists all the attributes advanced by the students and encourages all the students to participate.

Teacher Now I am proceeding with two other examples focus your mind on negative examples as given here.

Negative examples



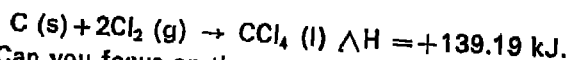
Now, prepare a list of characteristics of this reaction which are common to positive example and form your opinion about the attributes which are not applicable to the concept that I wish to teach.

Student 4 The non examples are endothermic and exothermic reactions, so the enthalpy of reaction should not be the concept.

Student 8 Non essential attributes are spontaneous processes and redox reactions, so these characteristics are not the essential parts of the new concept.

Student 2 Change of state of one reactant is common in both the examples and non examples, so it should be deleted amongst attributes.

Teacher That is nice. Now I am giving you one more positive example of my point as stated below



Can you focus on the essential parts of the attributes.

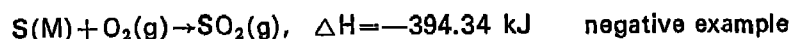
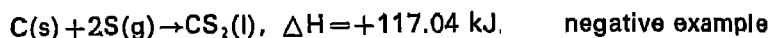
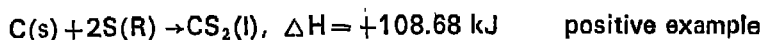
Student 9 Exothermic reaction and combustion cancel out.

Teacher Here we find that all the nonessential attributes cancel out. Can you suggest what is the concept in my mind.

Student 10 In positive examples one mole of the product is formed with change in enthalpy.

Teacher Very good, you are approaching towards the concept in my mind. Now I am writing some more positive and negative examples. Focus on them.

Teacher writes—



In all these examples one mole of the products is formed. See carefully the difference between the examples and non examples and try to arrive at the concept.

Student 6 In standard state, sulphur exists as sulphur-rhombic while in non examples S(g) and S(m) being considered.

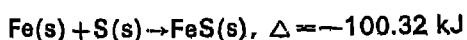
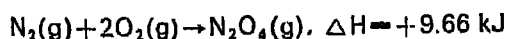
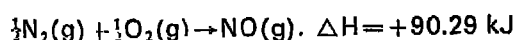
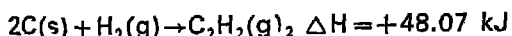
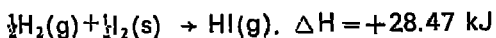
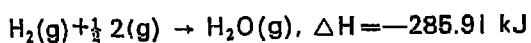
Teacher Very good. Now you seem to have attained the real concept in my mind, called the **enthalpy of formation**.

Teacher Can you define the enthalpy of formation from these attributes.

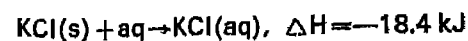
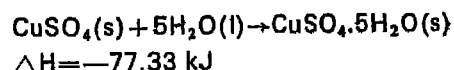
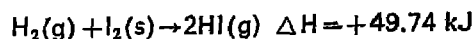
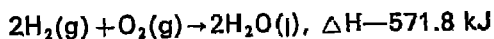
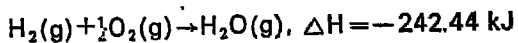
Student 3 Change in enthalpy that takes place during the formation of one mole of the product in its standard state from the elements in their standard state is called the enthalpy of formation of a compound.

Phase Two Teacher at this stage presents unlabelled examples and student categorize them as yes and no examples

Yes examples



No examples



Teacher You are right. I am confident that you have picked up the concept, I wished to talk about enthalpy of formation, which you have rightly defined and categorised in the examples.

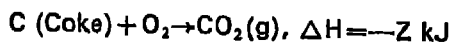
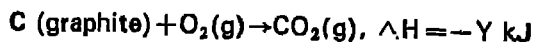
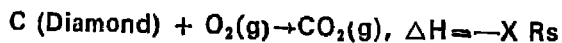
Questions to arouse critical awareness of students about essential attributes.

1. Sodium Chloride is crystallised from its saturated solution as indicated by the following equation.

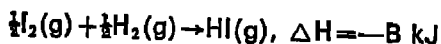
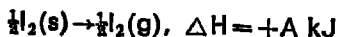


Justify whether $-X$ is the enthalpy of formation of sodium chloride or not.

2. Pick up out of the following equations, the examples for enthalpy of formation.



3. In the reaction—



Comment on the statement that $A-B \text{ kJ}$ is the enthalpy of formation of $\text{HI}(\text{g})$.

Model Lesson In Chemistry

on Concept Attainment Model

Type—Reception Oriented Model

V. R. Mahandule
Residential Jr. College
Ahmednagar

Class—XII

Concept—Arrhenius Acids

Essential Attributes

1. Compound ionising to furnish H^+ ions in water.

Non essential Attribute

1. Solution turning blue litmus paper red.
2. Nature of acid.

General Behavioural Goals

Students should be able to —

1. define Arrhenius Acid.
2. give examples of Arrhenius acids.
3. differentiate between various types of Arrhenius acids.

PHASE One

Presentation of data and identification of concept

Teacher There are different types of compounds. They have different natures such as acidic substances basic substances and neutral substances. Today I am going to teach you some concept regarding a group of compounds having common characteristics. I would only be giving you positive and negative examples of my teaching point. You have to locate through characteristics of positive and negative exemplars, what I wish to teach you.

The first positive example of my teaching point is —:

Teacher $H_2SO_4(aq) \rightarrow 2H^+(aq) + SO_4^{2-}(aq)$ positive example.

Students, now you may suggest various characteristics of this aqueous solution, arising in your mind.

Student 1 H_2SO_4 is an inorganic compound.

Student 2 Aqueous solution of it turns, blue litmus paper red.

Student 3 It is composed of hydrogen and ionises in water to give H^+ ions.

Student 4 It gives SO_4^{2-} ions in water.

Teacher Are there some more characteristics that come to your minds ?

Student 5 Acid formed from SO_2 .

Student 6 It is a dibasic acid.

Student 7 It contains sulphur atom in its molecule.

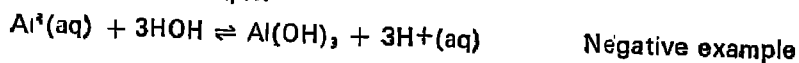
Teacher Well, has anybody more characteristics in mind ? Please mention, if any.

Student 8 It is a strong acid.

Student 9 It is an oxoacid.

Teacher lists out all characteristics (attributes) advanced by students on black board. Teacher should take care that maximum number of students participate during the course of discussion.

Teacher Now we have sufficient material to proceed ahead see, now I will give you one negative example.



Students compare the characteristics of positive examples with characteristics of negative examples. The common characteristics then are deleted, because these are not essential characteristics.

Student 3 Aluminium ion on hydrolysis produces acidic solution. So solutions which turn blue litmus paper red is non essential characteristic.

Teacher O.K., we will categorise it as nonessential characteristic.

Teacher Once again I will give you another positive example. Examine if some of the characteristics you have stated earlier could be labelled as nonessential.
 $\text{HCl}(\text{aq}) \rightarrow \text{H}^+(\text{aq}) + \text{Cl}^-(\text{aq})$

Student 8 Sir, HCl is not oxoacid.

Teacher All right, oxoacid term is nonessential.

Student 1 HCl solution does not give SO_4^{2-} ions. Moreover it also does not contain 'S' atom in its molecule. So those two characteristics become nonessential.

Teacher Yes, you are right. We will categorise them as nonessential characteristics.

Student 6 Hydrochloric acid is monobasic acid, hence dibasic becomes nonessential.

- Teacher : Yes, it is true. Are there any more characteristic which are nonessential ?
- Student 7 HCl isn't formed from SO₂. Hence it is formed from SO₂ is not essential characteristic.
- Teacher You are right. We will categorise it as non-essential. After this I am also presenting one more positive example. Examine it and tell me which nonessential characteristics are still possible to delete.
- $$\text{CH}_3\text{COOH (aq)} \rightarrow \text{CH}_3\text{COO}^- \text{ (aq)} + \text{H}^+ \text{ (aq)}.$$
- Student 5 Acetic acid is a weak acid. Hence strong acid characteristic holds no more good.
- Teacher Well, strong acid is also nonessential characteristic.
- Student 2 Acetic acid is organic acid. Hence inorganic acid characteristic is also not necessary.
- Teacher Yes, let us put inorganic acid as nonessential characteristic.
- Teacher Now compare characteristics of positive and negative examples to highlight what is my teaching point.
- Student 2 Compounds which when dissolved in water furnishing H⁺ ions may be your teaching point.
- Teacher How did you come to this point ?
- Student 2 Because only essential attribute remaining is Compounds capable of furnishing H⁺ ion when dissolved in water.
- Teacher Yes. You have thought in the right direction.

PHASE Two

Teacher at this stage presents the following unlabelled examples and students categorize them as yes examples or no examples.

Yes examples	No examples
HNO ₃ (aq)	ZnCl ₂ (aq)
HCN (aq)	AlCl ₃ (aq).
H ₃ PO ₃ (aq).	LiCl (aq).
HBr (aq).	CrCl ₃ (eq).
C ₆ H ₅ COOH (aq)	FeCl ₃ (aq)

- Teacher Good, I am confident that you have picked up my idea. I wished to talk about "Hydrogen containing compounds which when dissolved in water furnish H⁺ ion/ions. These are called as Arrhenius acids".

Teacher at this stage asks students to present further examples and point out essential attributes in the examples.

Questions to arouse critical awareness of students about essential attributes.

Q. 1 Define the term - "Arrhenius acid".

Q. 2 Classify following acids as :-

A) Arrhenius acids

B) Acids other than Arrhenius acid.

i) HCOOH (aq)

ii) $\text{H}_2\text{CO}_3 \text{ (aq)}$

iii) $\text{Cu}^{2+} \text{ (aq)}$

iv) HCN (g)

v) $\text{H}_2\text{C}_2\text{O}_4 \text{ (aq)}$

vi) BF_3

vii) HCl (g) .

Q. 3 Identify acids from following examples.

What is your opinion about remaining compounds ?

i) HCl (aq)

ii) NaOH (aq)

iii) $\text{H}_2\text{SO}_4 \text{ (aq)}$

iv) $\text{HNO}_3 \text{ (aq)}$

v) KOH (aq)

vi) $\text{Ca (OH)}_2 \text{ (aq)}$

Q. 4 Indicate the complete ionization pattern of the following substances and hence indicate their basicity.

i) HI

ii) H_2SO_4

iii) H_3PO_4

iv) $\text{H}_4\text{P}_2\text{O}_7$

Model Lesson in Chemistry

On Concept Attainment Model

Type ; Selection Oriented Model

(i) A. N. Saxena, Lect., Gwalior

(ii) I. M. Pathak, Lect., Rewa

(iii) J. K. Jain, Lect., Kohka. Bhilai

(iv) T. R. Verma, Lect., Balod.

Class—XII

Concept—Amines and their basic behaviour

Type—Disjunctive

Essential Attributes

Amines are the alkyl and/or aryl derivatives of ammonia.

Non essential Attributes

- i) Compounds containing C, H, N
- ii) Compounds containing lone pair of electrons on nitrogen
- iii) Water soluble compounds
- iv) Weak bases
- v) compounds turning red litmus blue
- vi) Compounds producing salts with acids.

General Behavioural Goals

Students should be able to—

- 1. define amines
- 2. label the compounds as amines
- 3. distinguish between primary secondary and tertiary amines.

Phase One Presentation of data and Identification of concept

Teacher Students you have already studied the different classes of organic compounds, such as alcohol, acids. Let us today study one more type of organic compounds.

Teacher Gives a set of examples and asks the students to pick-up any example from the following set of examples.

Examples

1. NH_4OH

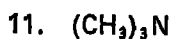
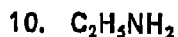
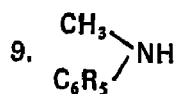
(2) Al(OH)

(3) $\text{C}_6\text{H}_5\text{NH}_2$

4. CH_3NH_2

5. $(\text{C}_6\text{H}_5)_2\text{NH}$

6. $(\text{CH}_3)_4\text{N}^+\text{Cl}^-$



Students activity Student selects CH_3NH_2 as an example.

Teacher It is a positive exemplar, now suggest the characteristics of CH_3NH_2 .

Students activity Following attributes are given by the students—

- 1) Compounds containing C, H and N
- 2) Alkyl derivative of NH_3
- 3) Compounds which contain lone pair of electron on nitrogen
- 4) Water soluble compounds
- 5) Weak organic base
- 6) Compounds giving salts with acids.

Teacher Now pick up another example.

Student Suggests $\text{C}_6\text{H}_5\text{NH}_2$ as an example.

Teacher It is also a positive example. Now suggest any other characteristics in addition to previous attribute.

Student Some more attributes are as follows

- i) Compounds turning red litmus blue
- ii) Aryl derivative of Ammonia.

Teacher Pick-up any other example.

Student Student suggest NH_4OH as an example.

Teacher It is a negative example. Now suggest the attributes of NH_4OH .

Student suggest following attributes

- i) Weak base
- ii) Water soluble

Teacher Pick-up other example.

Student Student suggests NH_3 as an example.

Teacher It is a negative example. Now suggest the attributes of NH_3 .

Student Nitrogen having a lone pair of electrons

Teacher Pick-up any other example.

Student Suggests $\begin{array}{c} \text{C}_6\text{H}_5 \\ \diagup \\ \text{CH}_3 \diagdown \\ \text{NH} \end{array}$ as an example.

Teacher It is a positive example. Now suggest the attributes of $\begin{array}{c} \text{C}_6\text{H}_5 \\ \text{CH}_3 \end{array} \text{NH}$

Student It is a mixed methyl-phenyl amine showing almost some behaviour as CH_3NH_2

Student Sir, another example of aryl amine may be taken in to consideration.

Teacher It is $(\text{C}_6\text{H}_5)_2\text{NH}$. Now give more attributes. By comparing these attributes, finalise the characteristic, critical attributes of the positive examples.

Student i) Contains lone pair of electron may be omitted.

ii) Water soluble may be omitted

iii) Weak base may be omitted.

iv) Turns red litmus blue may be cancelled.

v) Gives salts with acid may be omitted.

Teacher Now students, give central idea of my teaching point.

Student The amino organic derivatives having alkyl or aryl group or both showing basic nature are called amines.

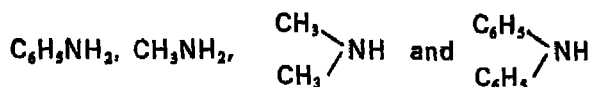
Phase Two

Teacher Alright you may be correct. Now on the basis of this idea classify the remaining examples.

Student	Positive Examples	Negative examples
	i) $(\text{C}_6\text{H}_5)_2\text{NH}$	i) $\text{Al}(\text{OH})_3$
	ii) $(\text{CH}_3)_3\text{N}$	ii) $(\text{CH}_3)_4\text{N}^+\text{Cl}^-$
	iii) $\text{C}_2\text{H}_5\text{NH}_2$	iii) $\text{CH}_3\text{NH}_2\text{HCl}$
		iv) $\text{Ca}(\text{OH})_2$

Question to arouse critical awareness of students about essential attributes

1. Arrange the following amines according to increasing basic character and also give reason in support of your answer



2. Why is trimethyl amine less basic than dimethylamine ?
3. Pyridine is somewhat soluble in water, whereas benzene is not. Why ?

4. How does the law of chemical equilibrium help us to explain the basicity of amines ?

5. What is the IUPAC name of the compound $\text{H}_3\text{C}-\overset{\text{NH}_2}{\underset{\text{CH}_3}{\text{C}}}-\text{CH}_3$, what is tertiary as well as primary in it ?

Appendix — II

**List of participants who attended the programme from 29-1-90 to 3-2-90,
Venue of Programme R.C.E., Bhopal.**

- | | |
|--|---|
| 1. Mr. Anil N. Saxena,
Govt. H. Hr. Sec. School,
Gwalior | 14. "Ghemud S. Nanabhi
Jr. College of Science
Parangut, Tal. Mulsai, Pune |
| 2. Mr. Inderamani Pathak,
Govt. M. Hr. Sec. School,
No. 1, Rewa | 14. "B. M. Sharma,
Govt. Hr. Sec. School,
No. 1, Shivpuri |
| 3. "M. Shaik Rafiq,
L.B. Shastri Jr. College,
Bhendara M.S. | 15. "Gite T. Ganpati,
Shri Shivaji College,
Parbhani |
| 4. "S.K. Saxena,
Govt. Women B.T.I.
Jabalpur | 16. "M.V. Ramdas,
Residential Jr. College,
Parbhani |
| 5. Mr. F.G. Dave,
J.P.B. Govt. Girls Hr. Sec. School,
Damoh | 17. "Dixit G. Sitaram,
A/p Taluka-Guhagar,
Dist. Ratnagiri |
| 6. "Waman G. Barsadage,
Z.P. (Ex-Govt.) Hr. Sec. School,
Gadchiroli | 18. Mr. J. K. Jain,
Govt. H. Sec. School,
Kohka Bhilai Dist. Durg. |
| 7. "K.P. Pande,
Govt. Hr. School,
Chandameta | 19. "T. R. Verma,
Govt. H. Sec. School
Balod, Dist. Durg. |
| 8. "I.C. Patal,
Hr Sec. School,
Silvassa | 20. Mr. M.M. Sahu,
Govt. Hr. Sec. School No. 1,
Jangjir Dist. Bilaspur. |
| 9. "B.P. Harikisan
D.B.F. Dayanand College
of Arts & Sci., Solapur | 21. Mr. S. K. Hussain
Govt. Hulti, Hr. Sec. School
Raipur |
| 10. "Patil S. Vitthalrao,
A.G. Jr. College of Science,
Dapoli, Dist. Ratnagiri | 22. Mr. S K. Sharma,
Govt. Hr. Sec. School,
Saragaon |
| 11. Mr. R.G. Dafade,
J.B. College of Science,
Wardha | 23. "S.C. Bhatt,
Govt. Hr. Sec. School No. 2,
Shahdol M.P. |
| 12. Patil A. Dattatraya,
Sadhana (R.R. Shinde),
Jr. College, Hadapsar, Pune | |

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